MAR 16 1943
Medical Library

SERIES 3, Vol. 26, No. 3 MARCH, 1943

AMERICAN JOURNAL OF OPHTHALMOLOGY

CONTENTS

		PAGE
Entoptic methods in clinical investigations	*B. Friedman*	235
Effect of mydriatics upon intraocular pressure	*P. C. Kronfeld, H. I. McGarry, and H. E. Smith*	245
Metastatic orbital infection	*F. E. Burch*	253
Metabolism of the ocular tissues	*F. W. Tauber and A. C. Krause*	260
Diagnosis of ocular syphilis	*B. F. Payne*	266
Near horizontal phoria and duction tests	*S. V. Abraham*	271
Studies of the infectivity of trachoma. XII	*L. A. Julianelle*	280
Metastatic panophthalmitis with recovery	*H. C. Donahue*	283
The vitamins in ophthalmology	*A. J. Baer*	286
Lagrange's law in war injuries	*P. S. Soudakoff*	293
A confirmation test for refraction	*C. Berens*	297
Clinical use of atropine	*S. Engel*	297
Electro-surgical excision of pterygium	*D. B. Kirby*	301
Memory aids in the measurement of strabismus	*J. I. Pascal*	302
Paresis of accommodation after sulfadiazine therapy	*J. Laval*	303

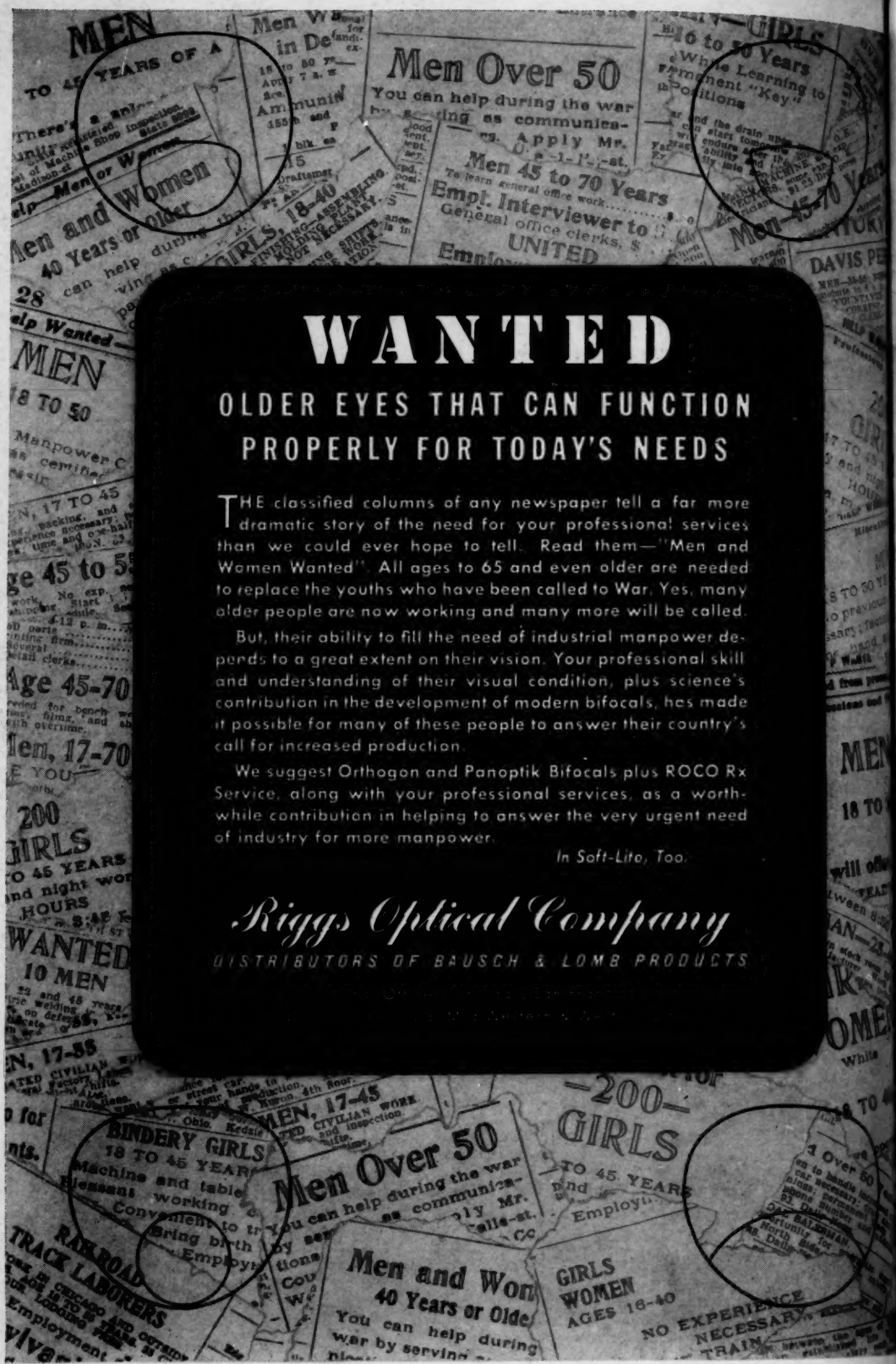
DEPARTMENTS

Society Proceedings	305
Editorials	319
Book Notice	324
Abstracts	325
News Items	341

For complete table of contents see advertising page V

Copyright, 1943, Ophthalmic Publishing Company, 837 Carew Tower, Cincinnati, Ohio

Subscription price in United States ten dollars yearly. In Canada and foreign countries twelve dollars. Published monthly by the George Banta Publishing Company, 450 Ahnaip Street, Menasha, Wisconsin, for the Ophthalmic Publishing Company. Subscription and Editorial Office: 837 Carew Tower, Cincinnati, Ohio. Entered as second class matter at the post office at Menasha, Wisconsin.



WANTED

OLDER EYES THAT CAN FUNCTION PROPERLY FOR TODAY'S NEEDS

THE classified columns of any newspaper tell a far more dramatic story of the need for your professional services than we could ever hope to tell. Read them—"Men and Women Wanted". All ages to 65 and even older are needed to replace the youths who have been called to War. Yes, many older people are now working and many more will be called.

But, their ability to fill the need of industrial manpower depends to a great extent on their vision. Your professional skill and understanding of their visual condition, plus science's contribution in the development of modern bifocals, has made it possible for many of these people to answer their country's call for increased production.

We suggest Orthogon and Panoptik Bifocals plus ROCO Rx Service, along with your professional services, as a worthwhile contribution in helping to answer the very urgent need of industry for more manpower.

In Soft-Lite, Too.

Riggs Optical Company

DISTRIBUTORS OF BAUSCH & LOMB PRODUCTS

AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 26 MARCH, 1943 NUMBER 3

ENTOPTIC METHODS IN CLINICAL INVESTIGATIONS

BENJAMIN FRIEDMAN, M.D.
New York

The entoptic approach to certain clinical problems has not been fully exploited. Many entoptic observations cannot be put to practical use, but there are situations where entoptic methods might promise possibilities even to the severely practical ophthalmologist. The following account is an attempt to point out several procedures which seem worthy of further exploitation. Some of them have not been attended by a sufficient number of reports to merit adoption, or, by the same token, to deserve abandonment. Others definitely belong in the clinician's armamentarium and need only to be remembered at the proper moment. The list is by no means comprehensive; selection was dictated partly by the paucity of references in current publications to the particular subject matter. Numerous instances were omitted because they are already incorporated in standard textbooks.

ENTOPTIC TESTS FOR RETINAL FUNCTION

a. Pressure phosphenes. The introduction of the ophthalmoscope consigned to disuse a method of exploring the retinal function which would still furnish important information today if generally remembered and practiced. Serre d'Uzès[1] utilized the phosphene circles that are produced by pressure upon the sclera to provide an insight into the vitality of the retina, and he particularly recommended that cataractous patients be examined in this manner before operation in order to avoid the disappointments of a successful extraction in an eye with a damaged retina or nerve. He found that the amaurotic retina,[2] even when it can perceive night and day, does not produce the phosphenes. He quite properly explained the luminous effect of pressures on the retina[3] as being similar to that of rays of light striking the same area from a forward direction (the difference being that the pressure stimulus is inadequate). The phosphene ring is projected through the nodal point to the opposite field.

Instances in which retinal exploration by means of pressure phosphenes might be highly informative are not rare in clinical experience. In cases of dense corneal opacities, cataract, occlusio pupillae, and secondary membrane, it is imperative to know if the risk of operation is warranted by the presence of a viable perceptive and conductive apparatus. The ability or the failure of the patient to project light is at times not sufficiently definite. A detached retina may project light quite faithfully. Exploration of the retina by pressure phosphenes may direct suspicion to a retinal detachment even when the projection of light is accurate. If the detachment is complete no phosphene circles will be observed; if partial, the area corresponding to the intact retina will yield luminous circles, but the detached portion will not. Gross field defects due to glaucoma would be readily detected, and the worth of such data is quite obvious when cataract surgery is contemplated in a

glaucomatous eye. Field defects due to atrophy of the optic nerve from other causes, and field defects due to lesions in the brain tracts will be recognized by the absence of phosphene circles in the dead areas.

An exemplar of the profitable use of this method is the following:

A. C., aged 19 years, was the victim of an intraocular foreign body which produced a dense traumatic cataract. The foreign particle was removed without difficulty, and several months later the extraction of the cataract seemed in order. The patient was able to project light perfectly, but palpation with a glass rod over one area of the sclera induced no phosphene circles. Operation was withheld on this account, and the propriety of this decision was confirmed a short time afterwards, when the patient lost his capacity for projecting rays of light that were directed toward the suspected area. The absence of pressure phosphenes furnished an earlier indication of the retinal detachment than did the faulty projection.

b. Purkinje's vascular figure. The ability to visualize the retinal vascular pattern entoptically may be of great importance in selected cases. Purkinje's method of diascleral illumination by means of focussed light has been modified, first by Brückner,[4] who utilized a Sachs transilluminator, then by Eber,[5] who used the ophthalmoscope bulb, and finally by Bretagne,[6] who employed the slitlamp beam. In the presence of opaque media the retinal figures may yield considerable information.[3,7,8,9] The vascular figure will be absent in an area of retinal detachment even when the same area may project light perfectly. Areas of chorioretinitis also will show localized defects in the vascular pattern. In the same manner sizable field defects due to glaucoma or to lesions in the nerve tracts may be discovered. Central visual defects from amblyopia ex anopsia, retrobulbar neuritis, or chorioretinitis are not difficult to determine, and such knowledge is of prime value in anticipating the vision that might be expected from operative intervention in cases of obstructed media.

c. Weekers's sign. All scotometric studies are in reality entoptic delineations of blind areas in the visual topography. A rapid and simple method of bringing out central defects is that described by Weekers.[10] The eye that is not being tested is covered by a patch; the eye under investigation is directed to the center of a sheet of blank white paper which is evenly illuminated and held at about reading distance. The eye is blocked by a card and then the screen is suddenly withdrawn. A central scotoma manifests itself as a grayish or bluish area, the size and contour of which vary with the individual case. After a few experiments the average patient has no trouble reproducing it quite accurately with a pencil. A positive Weekers sign has been considered pathognomonic of retrobulbar neuritis due to tobacco-alcohol,[10,11] but I have found it in central defects due to a large variety of causes. For example, it is easily elicited in cases of old or recent chorioretinitis regardless of the etiology, in retrobulbar neuritis due to multiple sclerosis, in macular edema from insufficient arterial supply of arteriosclerotic origin, and in central angiospastic retinopathy. It frequently provides an accurate clue to an irregularly shaped scotoma which might be more elaborately but more laboriously plotted at the tangent screen. Weekers's method is often quite sensitive and occasionally reveals details which are not available to tangent-screen scotometry.

d. Bielschowsky's test. Bielschowsky's test[12] for macular correspondence depends upon the entoptic identification of the right and left maculas, respectively, by means of a vertical afterimage in one eye and a horizontal afterimage in the other. Debora Dicke[13] reports that brief

periods of macular stimulation may temporarily convert eyes showing an anomalous macular correspondence by the Bielschowsky test to normal correspondence; such cases seem to offer a more favorable outlook than those in which the afterimages consistently remain anomalous.

e. Drews's test. Drews[14] combined the Bielschowsky afterimage in one eye with diascleral illumination in the other eye (Eber). It is possible by means of this combined test to localize the position of the macula within an extensive central lesion provided the other eye is able to furnish a linear afterimage. The diagnosis of heterotopia maculae was substantiated in this manner in an instance in which a lesion lay adjacent to an abnormally positioned macula.[15]

f. Stimulation by roentgen rays. The sensitivity of the eye is ordinarily thought of as being restricted to the wave bands of visible light in the energy spectrum, but the eye is susceptible also to the influence of a magnetic field, to radium, and, in the dark-adapted state, to roentgen rays.[16,17,18,19] If the closed eye is exposed to the emanations of an X-ray tube, a strong glow of light becomes evident. If a perforated lead screen is interposed, and the X rays allowed to strike the sclera laterally through the perforation, a localized stimulation is effected, and this will assume the shape of the aperture. The rays will pass first through the temporal and then through the nasal sides of the retina, and in so doing will create a reduplicated glowing spot. The one corresponding to the temporal retina is the more vivid. The rays are not refracted, hence their movement will appear reversed, and an opaque letter held before the closed eye will create a shadow on the retina equal in size to the letter, if the incident roentgen rays are parallel. A straight slit in a lead screen will often appear as a curved line because of the sphericity of the retina.

The first suggestions for the diagnostic applications of these experiments seem to have come from Crzellitzer,[20] who thought that patients with cataract, blood in the anterior chamber, and other opacities in the media, might be tested by means of X rays. Pirie[21] enumerated several additional specific situations in which X-ray stimulation might be of practical use. He noted that a lead letter could be projected upon the retina of the closed eye in legible form, and the testing of visual acuity by this means recommended itself as an immediate corollary. He suggested that defects in the visual fields from retinal or optic-tract lesions could be discovered and could be mapped upon the shadows of an opaque grid interposed before the eye. He found that an intraocular foreign body could be visualized subjectively, and its location could be roughly determined by observing its relationship to an opaque ring with cross bars held before the eye. He proposed an ingenious method of differentiating between an extraocular and an intraocular foreign body. If the foreign body is external to the retina it will cast a double shadow on the retina, whereas if it lies internal to the retina only a single shadow will be evident. This test, theoretically at least, should be extremely helpful in those cases in which the radiologist finds it impossible to localize the foreign body with certainty. Newell and Borley[22] report only indifferent success with this test, but the procedure, nevertheless, seems worthy of trial in every equivocal case.

Gifford and Barth[23] made use of the visible properties of X rays in the partially dark-adapted eye to gauge the visual acuity. They employed a lead

screen with apertures of 5 mm. to 0.2 mm. in diameter, graded in eight steps. The results were only incompletely successful, due to several factors. First, the visible action of the roentgen rays is upon the rods and not upon the cones. Thus the "image" of a slit directed near the posterior pole is seen as a straight line with a defect in its center, which corresponds to the macula; that is to say, for low intensities, X rays cause a relative central scotoma. For this reason the most important section of the retina, from the standpoint of vision, remains inaccessible to stimulation by this means. Second, an aperture that corresponds to 1 minute of arc, or the unit of the 20/20 letter, would have to be 0.0042 mm. in diameter. Such an opening is mechanically impossible to achieve in a metal screen, and even if it were feasible it would not be recognized, since Gifford and Barth found that the smallest opening which permitted visibility had to be 0.2 mm. in diameter. An image of this extent is 50 times the angular size of a 20/20 letter unit, and would correspond to a visual acuity of 20/1,000.

Newell and Borley encountered the same difficulties in roentgen tests for visual acuity. They measured the ability of patients to resolve the images of double holes in a lead screen, and they found the practical size limit of such holes to be equivalent to a visual acuity of 15/200. Computed upon an energy basis they estimated the stimulating power of roentgen rays upon the retina to be only 0.0002 that of light; the use of smaller apertures would require an X-ray intensity that would be impracticable.

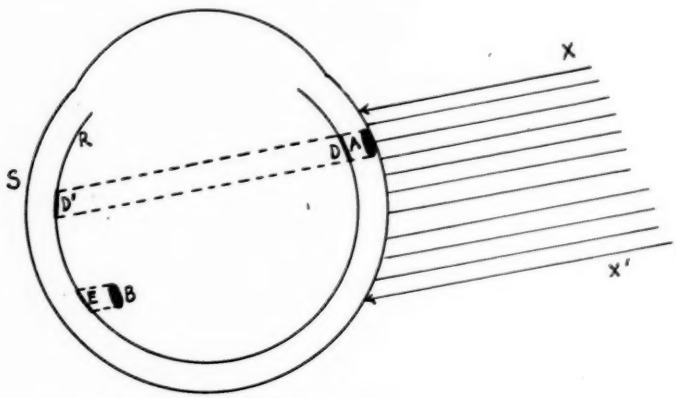


Fig. 1 (Friedman). X X' indicate the direction of the roentgen rays; A, a foreign body that has not perforated the retina: it will cast a double shadow at D and D'; B, a foreign body that has perforated the retina: it will cast a single shadow at E; S, sclera; R, retina.

The chief inherent fault of this method lies, therefore, in the selective action of the X rays upon the rods; but even if the cones were sensitive there would be the mechanical problem of creating apertures fine enough to correspond to the smaller lines of the Snellen scale, and after that there would still remain the difficulty of providing sufficient stimulating intensity through such tiny openings.

Nevertheless, the results of Newell and Borley's clinical investigations are interesting and worth repeating. They tested patients with scotoma ranging from 2° to 3° (relative) to 20° (absolute), caused by toxic amblyopia and various retinal lesions. Most of the scotomata

were brought out by the roentgen tests. In 43 cataract patients who had a final visual acuity of 20/30, about 80 percent were able to resolve the smallest pattern in the screen; with vision 20/40 or worse, only about 50 percent were able to resolve even larger patterns. In three cases of corneal transplantation the ultimate good vision obtained was anticipated by the roentgen test in all instances. In spite of the paracentral origin of the responses these clinical data would indicate that roentgen testing of visual acuity is not without some value.

Retinal chronaxie

The response of a tissue to an electric stimulus occurs only if several requisites in the stimulating current are satisfied: the rate of increase of current intensity must exceed a definite velocity, the final intensity must attain a certain minimum level, and lastly the current must flow for a certain minimal duration. The time element is denoted by the term chronaxie* (Lapicque, 1909). Investigations of the retinal chronaxie have yielded data which may be of importance in the better understanding of neuroretinal disease.

The excitability of the optic system in terms of chronaxie may be studied by means of phosphenes that are produced by the passage of an electric current through the eye.[24] A small active electrode is held in contact with the lid over the region of the globe selected for stimulation, while the indifferent electrode is placed in contact with another part of the body. The current discharge takes place from a variable condenser or from a source of constant current; in either case the duration of flow can be recorded in extremely short time values. The experiment is performed in a semidark room. The patient fixates on a target directly ahead and is requested to localize the phosphene in his visual field.

a. Retinal chronaxie in health. The phosphenes are either central or peripheral in location.[25] The central phosphenes are produced by holding the electrode against the lid so that the current enters the eye at the level of the lower border of the pupil. The peripheral phosphenes are induced by stimulating the peripheral parts of the retina, and, paradoxically, these phosphenes are localized just under the stimulating electrode instead of being projected to the opposite field. Phosphenes produced in the manner described (direct stimulation) are "local" phosphenes.[26] When the eye is turned so that the electrode lies somewhere near the optic disc (indirect stimulation), the phosphenes become "distant," being projected in the macular field (central distant), or at other times to the opposite field (peripheral distant). Two chronaxies are found in the retina.[25] The central phosphenes, local or distant, require a current passage time of 2.1 to 3.0 σ, while the peripheral phosphenes, local or distant, require only 1.2 to 1.8 σ. Some observers[27] have found higher figures for the upper limits.

It is thus apparent that two zones of different excitability exist in the human eye; the one with the longer excitation period corresponds to the region of the cones, while the more sensitive zone lies in the territory of the rods.

b. Retinal chronaxie in disease. Preliminary chronaxie studies in pathologic conditions seem sufficiently important to

* If a continuous current of relatively long duration is used, and the voltage increased from zero to the point where a tissue response is obtained, the threshold voltage is called the rheobase. If a current whose voltage is twice the rheobase is now employed, the shortest duration of current flow that will evoke a response is defined as the chronaxie. The chronaxie is measured in thousandths of a second and is expressed in multiples of the symbol sigma (σ). $\sigma = 0.001$ second.

merit further attention. Courland[28] cites a case of descending optic-nerve atrophy following a bullet wound in the brain. He discovered similarities between the optic chronaxies in this case and the chronaxies of other nerves undergoing degeneration. Bourguignon had found that at the beginning of peripheral-nerve degeneration there is a decrease of the chronaxie, sometimes to one half or one third its normal value; then it increases considerably and passes beyond the normal values. At the onset, when no clinical evidences of degeneration are manifest, the chronaxie gives advance information. Courland found some of the chronaxie measurements in his patient to be diminished, others augmented, and in his opinion these mixed readings were due to unequal degeneration of the nerve fibers occasioned by the uneven destruction of brain tissue. He records also an instance of bilateral retrobulbar neuritis in which stimulation induced peripheral but no central phosphenes. This would indicate serious damage to the papillomacular bundle. In other cases in which there were central scotomata, he found normal central chronaxies quite readily. Thus in cases which give the same scotometric signs, chronaxie testing may detect those with macular-bundle degeneration and may thereby assist in prognostication.

Bourguignon, Courland, and Dejean[29] came to similar conclusions in cases of retrobulbar neuritis. In a case of syphilitic pigmentary chorioretinitis they found unaltered central and peripheral chronaxies. Since the major pathologic changes in this condition, at least in the beginning, are limited to the rods and cones, they felt justified in offering the normalcy of the chronaxies as proof that the rods and cones are not influenced by electric stimuli. Such an hypothesis appears to be substantiated by other evidence.[30] In studies on an albinotic patient they found differences between the chronaxies resulting from direct and indirect excitation, and they explained this heterochronism as a functional dissociation between the bipolar and multipolar neurons. Normally, there is isochronism between functionally associated pathways; in the albino the bipolar neuron seems to have altered its chronaxie. These workers came to the general conclusion that chronaxie studies in pathologic material offer a means of localizing the lesions in the rods and cones, the bipolar, or the multipolar cells. Lesions of the rods and cones do not modify the chronaxies. Injury to the bipolar neurons influences the local phosphenes, whereas disease of the multipolar neurons alters the distant phosphenes.

Chronaxie measurements were employed by Lobel and Brecher[31] to investigate the functional state of the retina in cases of cataract and other obstructions in the media. In complete amaurosis they found a total absence of phosphenes. In retinal detachment and choroiditis the chronaxie related to the bipolar neurons appeared elevated; in papilledema and in optic neuritis the bipolar ganglia in particular were affected.

Much more evidence is necessary before such nice localization of injury can be accepted as valid; the clinical reports submitted were by no means complete, and some of the conclusions bear the stigma of wishful thinking, but the problem constitutes, at the very least, an interesting and important challenge.

Last and Laubenthal[27e] found that considerable normal variations in chronaxie exist, but these are smaller than the variations that occur in pathologic cases. There were no definite differences between the chronaxies in peripheral disease of the optic nerves and injuries to the central optic tracts. In optic atrophy there was a high increase in the rheobase and at

times in the chronaxie. In a case of bilateral retrobulbar neuritis from multiple sclerosis there was an increase in both rheobase and chronaxie. In a case of unilateral retrobulbar neuritis from multiple sclerosis there was a pathologic change in chronaxie and rheobase in the affected eye, but not in the good eye. In a case of unilateral papilledema with macular star there was a definite increase in the threshold compared to that of the other eye.

Ruffin[27d] found elevation of the ocular chronaxie in fatigue, chronic alcoholism, and in acute schizophrenia, especially when visual hallucinations were present.

Not all observers[32] are able to verify the definite correlation between the position of the electrode and the position of the phosphene that was noted by Bourguignon and his colleagues, nor do they all confirm the division of the retinal area into zones of separate chronaxies. Bourguignon[33] explains these inconsistencies on the basis of differences in equipment and technique.

c. Physiologic experiments in connection with retinal chronaxie. Data relative to the effects of dark and light adaptation on the retinal chronaxies are conflicting[34] but in most instances the rheobase and chronaxie values of the dark-adapted eye appear to be higher than those of the light-adapted eye. The adaptive state of one eye influences the rheobase and chronaxie values of the other eye;[32a, 32b, 34k] if the mechanism of adaptation was strictly limited to the eye, such an interrelation would not be expected. Quite credible evidence indicates a process in the central nervous system that is connected with adaptation and is revealed by a measure of cortical control over chronaxie responses.

Flicker experiments with electric currents[30a] reveal a fusion frequency for the phosphenes of 120 stimuli per second; this rate is two to three times higher than the rate at which flicker ceases when light stimuli are employed. This observation tends further to link the central nervous system with the retinal response to the electric stimuli and to separate chronaxie phenomena from the photochemical factor of vision.

The mutual dependence of retinal chronaxie and other sensory impulses again bespeaks a cerebral connection. The retinal chronaxie is depressed by simultaneous acoustic stimuli of low intensity but is augmented by strong tones. High temperature lowers the chronaxie threshold, whereas olfactory and tactile stimuli raise it. Stimulation of the vestibular apparatus augments or depresses the retinal chronaxie depending on the initial excitability of the vestibular mechanism.[34j] Under the influence of muscular work the retinal chronaxie is increased; it returns to normal more slowly if the fatigue has been excessive.[35]

The electric current that induces the phosphenes acts upon the elements of the optic tract within the retina or nerve, but the rod and cone layer is not necessary to the production of phosphenes. Stimulation of a socket soon after enucleation of the globe, before nerve atrophy ensues, induces phosphenes via the nerve stump.[36, 30c]

If an electric current is discharged into the eye at the same instant that a visible light stimulus is caused to fall upon the retina, the phosphene reaches the optic centers in the brain before the light stimulus is able to register, and the interval between the perception of these two stimuli is equal to the reaction time of the receptor cells.[30b]

Entoptic pupillometry

Entoptic pupillometry began with Fick,[37] in 1856. When a very small light is placed so close to the eye that its rays

cannot be properly focused, a diffusion circle is formed on the retina. The circle is bounded by the projected borders of the iris. When two lights are used two diffusion circles are formed, and when the distance between the lights varies the relative positions of the diffusion circles correspondingly change. When the circles are so placed that their circumferences are tangent the distance between the lights will correspond to the diameter of

Fig. 2 (Friedman). Anterior opening of Cloquet's canal seen entoptically (after J. Burdon Cooper).

the pupil. Fick cut a V-shaped horizontal slit in a thin sheet of metal; this was covered by another sliding metal sheet that carried a vertical linear slit. By moving the vertical slit over the limbs of the V, two openings were created; the space between the openings varied with the distance of the vertical slit from the apex of the V. When the device was held before the eye, the openings acted as two movable light sources, and the distance between the two openings at the moment of tangency indicated the pupillary diameter.

Various modifications of Fick's apparatus were constructed by others,[38] but it remained for Javal[39] to reduce the method to admirable simplicity by using a metal sheet pierced by five pairs of holes from 2 to 4 mm. apart, each pair being spaced 0.5 mm. wider than the preceding pair.

Several subsequent experimenters[40] made changes in the number and spacing of apertures without altering the essential simplicity of Javal's apparatus. More elaborate means of measuring the distance between the light sources at the point of tangency were devised by others.[41]

Another method of studying the pupillary configurations is to project a single blur circle against a tangent screen[42] or a grid.[43]

Entoptic pupillometry is not unimpeachable upon mathematical grounds, but its clinical accuracy appears to have satisfied those who have worked with it. Certainly much information concerning the size, shape, and movements of the pupil can be obtained without recourse to complicated and expensive equipment.

Anatomic details

a. Hyaloid canal. The ocular tissues, by virtue of their delicacy, are in some respects better suited to entoptic study than to dissection or even microscopic examination; details referable to changes in transparency are often lost in anatomic preparations.

The anterior stoma of the hyaloid canal has been clearly described and beautifully illustrated by J. Burdon Cooper.[44] It may be readily observed in the illuminated field of a microscope. The vitreous strands, which form the boundary of the opening, are woven in a formation similar to the plaiting in the rim of a wicker basket. Under certain conditions the entire mouth is seen, but usually only a part of it is visible. It sways gently with the movements of the

eye and it is obviously not adherent to the lens. Cooper was able to visualize also what he believed to be the shadow of the posterior opening of Cloquet's canal.

b. Ora serrata. Pressure over the retina ceases to produce phosphene circles when the finger passes anterior to the ora serrata.[45] The moment the finger straddles the ora serrata only half a circle may be discerned, its concavity facing backward.

c. Response of the retinal vessels to drugs. Hess[46] has described a most interesting effect on the perifoveal vessels when 2-percent pilocarpine is instilled into the conjunctival sac. The vessels are viewed entoptically by moving a pinhole before the eye. Within 15 minutes the visibility of the small central vessels becomes lost. The phenomenon is accompanied by a central scotoma. The shagreen of the macular area disappears, and a dark spot forms in the center. The effect lasts about two hours, after which the capillary shadows return. The larger vessels seem not to be affected, and the presumption is that the pilocarpine has a specific effect on the terminal portions. Amyl nitrite or adrenalin do not deter the action of pilocarpine, and the size of the pupil is not a factor.

The capillary pressure, determined by entoptic means, is always high in glaucoma.[47] The capillary pressure of the normal eye is reduced by miotics.[48]

Amyl nitrite, acetylcholine, and adrenalin do not alter the entoptic appearance of the retinal vessels near the macula even when administered in amounts sufficient to cause severe general symptoms.[49] The retinal arterial pressure follows the cephalic arterial pressure, but the macular vessels apparently have a circulatory control quite peculiar to themselves,[50] and vascular changes near the disc are not necessarily visible near the macula. This fact ought to be borne in mind when evaluating therapy with vasodilators that are intended for action on the vessels of the optic nerve and retina. Histamine does cause a slight increase in the caliber of the paramacular vessels.[49]

6 West Seventy-seventh Street.

References

[1] Serre d'Uzès. Compt. rend. Acad. Sci., 1850, v. 31, p. 375.
[2] ——. Ibid., p. 587.
[3] ——. Ibid., p. 778.
[4] Brückner, A. Arch. f. Augenh., 1909, v. 64, p. 54.
[5] Eber, S. I. Amer. Jour. Ophth., 1922, v. 5, p. 973.
[6] Bretagne, P. Ann. d'Ocul., 1924, v. 161, p. 192.
[7] Goebel, K. Arch. f. Augenh., 1922, v. 90, p. 245.
[8] Friedman, B. Arch. of Ophth., 1931, v. 5, p. 637.
[9] Walker, C. Trans. Amer. Acad. Ophth. and Otol., 1939, p. 399; Amer. Jour. Ophth., 1940, v. 23, p. 803.
[10] Weekers, L. Arch. d'Opht., 1932, v. 49, p. 485; 1934, v. 51, p. 497.
[11] Joiris, N. Arch. d'Opht., 1935, v. 52, p. 578.
[12] Bielschowsky, A. Arch. of Ophth., 1937, v. 17, p. 408.
[13] Dicke, D. Amer. Jour. Ophth., 1942, v. 25, p. 585.
[14] Drews, L. Amer. Jour. Ophth., 1941, v. 24, p. 1403.
[15] Friedman, B. Arch. of Ophth., 1942, v. 28, p. 444.
[16] Brandes and Dorn. Quoted by Nagel, W., in Helmholtz, Physiological optics. English translation, Opt. Soc. of Amer., 1924, p. 22.
[17] Röntgen, W. Sitzungsb. d. k. Preuss. Ak. d. Wissensch. z. Berlin, 1897, v. 25, p. 576.
[18] Edison, T. Electr. Eng., 1896, v. 22, p. 601.
[19] Himstedt and Nagel. Quoted by Nagel. Loc. cit. (see Brandes and Dorn[16]).
[20] Crzellitzer, A. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1901, v. 5, p. 245.
[21] Pirie, A. Canad. Med. Assoc. Jour., 1932, v. 24, p. 488; Brit. Jour. Radiol., 1934, v. 7, p. 111.
[22] Newell, R., and Borley, W. Radiol., 1941, v. 37, p. 54.
[23] Gifford, S., and Barth, E. Arch. of Ophth., 1934, v. 11, p. 81.

[24] Bourguignon, G. La chronaxie chez l'homme. Paris, Masson et Cie, 1925.
[25a] Bourguignon, G. Arch. d'électr. méd., 1925, v. 33(509), p. 49. [b] ———, and Dejean, R. Compt. Rend. Acad. Sci., 1925, v. 180, p. 169. [c] ———. Compt. Rend. Soc. Biol., 1926, v. 94, p. 750.
[26] Bourguignon, G., Courland, M., and Dejean, R. Compt. rend. Soc. Biol., 1926, v. 94, p. 753.
[27a] Verryp, C. D. Compt. rend. Soc. Biol., 1925, v. 92, p. 742. [b] Stein, J. Bumke's Handbuch der Geisteskrankheiten. Ed. 1, Berlin, J. Springer, 1928, p. 352. [c] Schriever, H. Zeit. f. Biol., 1930, v. 90, no. 72, pp. 347, 383, 396. [d] Ruffin, H. Zentr. f. d. ges. Neurol. u. Psych., 1932, v. 140, p. 641. [e] Last, S., and Laubenthal, F. D. Zeit. f. Nervenh., 1933, v. 129, p. 278.
[28] Courland, M. La chronaxie neuro-retinienne. Thèse de Paris, 1925, no. 443.
[29a] Bourguignon, G., Courland, M., and Dejean, R. Comp. rend. Acad. Sci., 1926, v. 182, p. 1350. [b] ———. Bull. et mém. Soc. franç. d' Opht. de Paris, 1926, May, p. 252.
[30a] Bouman, H. Arch. Néerl. de Physiol. 1925, v. 20, p. 430. [b] Makarow, P. Bul. de Biol. et de méd. expér. de l'U.R.S.S., 1936, v. 2, p. 122. [c] Vishnevskiy, H. Viestnik. Opht., 1939, v. 15, nos. 3-4, p. 136.
[31] Lobel and Brecher. Soc. roumaine d'Opht. de Bucarest, 1930, Nov. 26. Rev. in Ann. d'Ocul., 1932, v. 169, p. 319.
[32a] Achelis, J., and Merkulow, J. Zeit. f. Psych. u. Physiol. d. Sinnesorg., 1929, v. 60, no. 2, p. 95. [b] Fischer, F., and vom Hofe, K. Arch. f. Augenh., 1932, v. 105, p. 443. [c] Bouman, H. See reference [30a]. [d] Last, S., and Laubenthal, F. See reference [27e].
[33] Bourguinon, G. Deutsche Zeit. f. Nervenh., 1933, v. 129, p. 288.
[34a] Müller, G. Zeit. f. Psych. u. Physiol. d. Sinnesorg., 1897, v. 14, p. 329. [b] Cords, R. Arch. f. Ophth., 1907, v. 67, p. 149. [c] Brückner, A. Ber. u. d. 38. Versamml. d. ophth. Ges., 1912, p. 220. [d] Verryp, C. D. See reference [27a]. [e] Bouman, H. See reference [30a]. [f] Lasareff, P. Arch. f. Physiol., 1923, v. 200, p. 119; Jour. f. Psych. u. Neurol., 1927, v. 35, p. 174. [g] Achelis, J. and Merkulow, J. See reference [32a]. [h] Fischer, F., and Vom Hofe, K. See reference [32b]. [i] Müller, G., Zeit. f. Psych. u. Physiol. d. Sinnesorg., 1934, v. 65, no. 2, p. 274. [j] Bogoslovsky, A. Bul. de Biol. et de méd. expér. de l'U.R.S.S., 1939, v. 8, p. 387. [k] Merkulow, J. Ber. d. Sächs. Acad. d. Wissen., mathem.-phys. Klasse, 1928, v. 80, p. 291.
[35] Marschak, M., and Schlykowa, A. Fiziologicheskiy jurnal, 1934, 17, p. 994.
[36] Wolochov, Gerschuni, Zagorulko, and Lebedinsky. Cited by Makarow, P. See reference [30b].
[37] Fick, A. Arch. f. Ophth., 1856, v. 2, no. 2, p. 70.
[38a] Crétès. Cited by De Wecker and Landolt, Traité d'Opht., Delahaye, Paris. ed. 1880, v. 1, p. 947. [b] Robert-Houdin. Congrès Intern. d'Opht., Paris, 1867, p. 66. [c] Badal, J. Ann. d'Ocul., 1876, v. 75, p. 290; Gaz. méd. de Paris, (ser. 4), 1876, v. 5, pp. 237, 273. [d] Bordier, H., and Nogier T. Rev. gen. d'Opht., 1907, v. 26, p. 529.
[39] Javal, L. Cited by Marmiton. Compt. rend. Soc. Biol., 1913, v. 74, p. 1360.
[40a] Jackson, E. Philadelphia Polyclinic, 1896, v. 5, p. 171; Amer. Jour. Ophth., 1942, v. 25, p. 871. [b] Williams, T. Med. Record, 1910, v. 78, p. 1148. [c] Marmiton. See reference [39]. [d] Cogan, D. Amer. Jour. Ophth., 1941, v. 24, p. 1431.
[41a] Pedrazzoli. Cited by Gaudenzi, C. Gior. d. R. Accad. d. Med. d. Torinno, (ser. 4), 1890, v. 5, pp. 62, 413. [b] Broca, A. Compt. rend. Acad. Sci., 1924, v. 178, p. 415; Rev. d'Opht., 1924, v. 3, no. 11, p. 493. [c] Moss F. Jour. Opt. Soc. Amer., 1932, v. 22, p. 735.
[42a] Lampis, E. Boll. Ocul., 1934, v. 13, p. 1492. [b] Viallefont, H., and Lafon, R. Arch. d'Opht., N.S., 1938, v. 2, pt. 2, p. 991.
[43] Jones, R. Jour. Opt. Soc. Amer., 1939, v. 29, p. 531.
[44] Cooper, J. Ophth. Rev., 1908, v. 27, p. 357; Trans. Ophth. Soc. United Kingdom, 1927, v. 47, p. 341.
[45] Encyclop. franç. d'Opht. de Paris (Lagrange, F. et Valude, E. ed.), 1904, v. 3, p. 819.
[46] Hess, C. Arch. f. Augenh., 1920, v. 86, p. 89.
[47] Dieter, W. Arch. f. Augenh., 1925, v. 96, p. 179; 1928, v. 99, p. 687.
[48] Fischer, F. Arch. f. Augenh., 1925, v. 96, p. 97.
[49] Viallefont, H., Ravoire, J., and Lafon, R. Bull. et mém. Soc. franç. d'Opht. (Paris), 1933, Dec., p. 673.
[50] Friedman, B. Arch. of Ophth., 1942, v. 28, p. 285.

THE EFFECT OF MYDRIATICS UPON THE INTRAOCULAR PRESSURE IN SO-CALLED PRIMARY WIDE-ANGLE GLAUCOMA*

PETER C. KRONFELD, M.D.,
AND (by invitation)
H. ISABELLE MCGARRY, M.D.,
AND (by invitation)
HOMER E. SMITH, M.D., M.C., U.S.N.R.
Chicago

The effects of mydriatics or cycloplegics upon the intraocular pressure of human eyes have been discussed repeatedly before this Society. A great deal of attention has been given to the so-called dilation glaucoma; that is, to cases of unexpected marked rise of the intraocular pressure following the local administration of mydriatics for the purpose of cycloplegia or examination of the fundus. Such cases have been reported by Derby in 1867, Green in 1880, Ring in 1903, Sutphen in 1916, Woods in 1923, and finally by Beach and E. E. Holt, Jr., in 1940. The last-named authors, as well as Verhoeff, in the discussion of Gradle's paper in 1935, stressed as "the most significant feature of this group the recurring mention of shallowness of the anterior chamber." Recent gonioscopic work[1] has shown that it is highly probable that the mechanism of the dilation glaucomas is that of an acute obstruction of the entrance to the chamber angle by the ruffled iris, combined, in some instances, with other angle-crowding factors. Also through gonioscopic evidence, it now appears reasonably well established that such an obstruction is possible only in eyes with a preëxisting narrowness of the angle that is usually, but not always, associated with shallowness of the entire anterior chamber.[2] By means of gonioscopy, or, more accurately, of goniometry,[3] it is possible to predict with reasonable certainty whether the intraocular pressure of a given eye will be disturbed by mydriatics and what degree of mydriasis will bring about this disturbance.

The present study concerns itself not with dilation glaucoma, but with the effects of mydriatics upon the intraocular pressure of eyes apparently affected with primary glaucoma, in which the mydriatics could not and did not produce any obstruction of the entrance to the angle, or, more specifically, did not alter the area of the corneoscleral trabeculum that was gonioscopically visible and therefore presumably accessible to the aqueous. The fulfillment of this requirement was verified by repeated gonioscopic examination during the action of the respective mydriatic. Borderline cases, in which the size of the gonioscopically visible area of the corneoscleral trabeculum may have been altered while the eye was under the influence of the mydriatic, were not included in this report. The fact that the intraocular pressure was elevated in the absence of any obstruction of the entrance to the angle places the eyes upon which this report is based in the group of so-called wide-angle glaucoma (O. Barkan). Strictly speaking, none of the work done in the pregonioscopic era can be considered as having any bearing on the problem of the effect of mydriatics upon wide-angle glaucoma. It is, however, reasonably certain that observations made on glaucomatous eyes that have deep anterior chambers are comparable to ours, even though the possibility of angle

*Read before the American Ophthalmological Society, at Hot Springs, Virginia, June, 1942.

obstruction was not definitely ruled out by gonioscopic examination. Motivated by the "widely accepted concept that the width of the pupil *generally* exerts a decisive effect upon the intraocular pressure," Koellner[4] made the first systematic study of the relationship between width of the pupil and intraocular pressure in cases of chronic simple glaucoma in which the anterior chambers were deep. In 12 out of 13 such eyes Koellner could not detect any influence of single or repeated instillations of homatropine, scopolamine, or atropine upon the intraocular pressure. In the thirteenth case, which was characterized by extensive spreading of pigment in the anterior chamber, a slight rise of tension (10 mm.) occurred five hours after homatropine was instilled. In his "mydriatic-negative" cases it appears that the tonometric measurements were made only two or three times daily, so that slight transient rises might have escaped recording. It also appears that no special attention was paid to the period during which the mydriasis and the cycloplegia are most pronounced; namely, during the first four hours following the instillation. Nevertheless, Koellner is entitled to the credit of having first shown that mydriasis and cycloplegia of varying degree do not dramatically alter the intraocular pressure in cases of chronic simple glaucoma in which the anterior chamber is deep.

No further reports on the effect of the parasympatholytic mydriatics upon the intraocular pressure in glaucoma appeared until Streiff[5] published his experiences with syntropan. In a few cases of glaucoma simplex this writer observed, after the instillation of syntropan, an increase in the intraocular pressure that could be promptly overcome by the instillation of a miotic. The type of glaucoma that was present in these cases, whether of the narrow- or of the wide-angle type, was, unfortunately, not stated.

After Hamburger recommended epinephrine and its congeners for the treatment of certain forms of glaucoma, the effects of the sympathomimetic drugs upon the intraocular pressure in so-called primary glaucoma have received a great deal of attention in the international literature as well as at the meetings of this Society. Here, again, it was our feeling that gonioscopy had much to offer toward a more accurate definition of the type of glaucomatous eye, the response of which to the sympathomimetic drugs is being studied.

The present study was undertaken to fill in some of the gaps in this work; namely, gonioscopic observations and more frequent tonometric measurements during the first few hours following the application of the mydriatic. We were also interested in determining whether a positive or negative response to the instillation of a mydriatic was of any diagnostic value in cases of suspected primary wide-angle glaucoma.

Procedure

Fifteen eyes which were apparently affected with primary, wide-angle glaucoma were chosen for this study. On the basis of the gonioscopic findings, they could be divided into three groups:

1. Eyes having wide angles and trabecular or scleral adhesions (nos. 1 through 5). In all these eyes the glaucoma was far advanced as evidenced by the extensive if not complete loss of the visual function.

2. Eyes having wide and entirely open angles but a moderate to marked amount of trabecular pigment infiltration of the trabeculum (nos. 6 through 12). The loss of visual function which had occurred in these eyes as the result of glaucoma varied from no demonstrable defect

(number 12) to amaurosis (number 8).

3. Eyes having entirely open angles and no visible anomaly of the trabecular area (nos. 13 through 15). In the eyes of this group the loss of visual function attributable to the glaucoma was slight.

In none of the 15 eyes had any surgical procedure been instituted. The use of miotics was discontinued at least 24 hours before the beginning of our study, which consisted of the observation of the variations in the tonometric reading as they occurred during control periods and under the influence of two instillations, 10 minutes apart, of the following three mydriatics:

5-percent homatropine hydrobromide,
2-percent paredrine hydrobromide,
5-percent homatropine hydrobromide dissolved in 2-percent paredrine hydrobromide.

The early afternoon hours were chosen for our study because of the greater stability of the intraocular pressure during this portion of the day. In most cases we confined ourselves to making three hourly tonometric measurements following the administration of the mydriatic. If the last one of these readings was definitely higher than the preceding one, the period of observation was extended, and usually a further reading was taken the following morning.

In an attempt to estimate the factor of ocular rigidity the tonometric readings were taken at first with two different weights. No consistent nor significant variations in ocular rigidity could be demonstrated with the Schiötz tonometers at our disposal. We therefore adopted the routine of taking the tonometric measurements with one weight only, and transposed the reading into millimeters of intraocular pressure using Schiötz's nomogram of 1924.

To be able to compare the possible diagnostic value of the response to mydriatics to that of well-established provocative tests, in the patients of our series, the drinking test of Marx and Schmidt was carried out. After the regular breakfast before 8:30 a.m., the patients received nothing by mouth until 1:00 p.m., when they drank, within three to five minutes, 1,000 c.c. of water. Tonometric readings were taken immediately before and every 20 minutes after the drinking until the initial tonometric level was reached again. (For a recent review of the value of the drinking test the reader is referred to the article by Ohm.[6])

While this work was in progress, we felt the need for a control series. We therefore subjected 36 control eyes with minor refractive errors, of individuals over 45 years of age, to the homatropine-paredrine procedure; that is, we determined the fluctuations of the tonometric readings as they occurred during the three hours following two instillations of 5-percent homatropine dissolved in 2-percent paredrine. (For a comprehensive review on the effect of mydriatics upon the intraocular pressure of nonglaucomatous eyes, the reader is referred to a recent doctor's dissertation by Gilde.[7])

Case reports

Case 1 (right) and *case 2* (left). M. P., a colored woman, aged 60 years, was amaurotic in the right eye; vision in the left eye was light perception only. The anterior chambers were moderately deep. Both angles were wide, and showed slight scleral adhesions and marked trabecular pigmentation. There were complete glaucomatous excavations and retinal arteriosclerosis.

Case 3 (right) and *case 4* (left). N. C., a white man, aged 51 years, had vision O.U. sufficient to count fingers eccentrically at one foot. Evidences of healed trachoma were present; there were small pterygia, deep anterior chambers, wide

angles, moderate trabecular pigmentation, and scleral synechias. Glaucomatous excavations were complete, and the visual fields showed only temporal islands.

Case 5 (right). W. B., a colored man, aged 44 years, had an amaurotic right eye and vision in the left eye of 20/40+3. The anterior chambers were deep. In the right eye were a wide angle, extensive trabecular adhesions, and a partial trabecular pigment ring; in the left eye, a wide angle and scattered trabecular adhesions, but no trabecular pigment ring. One small posterior synechia was present in each eye. The right eye had a total glaucomatous excavation; the left eye, a partial excavation.

Case 6 (left). T. F., a colored man, aged 56 years, had vision R.E. of 20/15; L.E., 20/200. The anterior chambers were moderately deep, the angles wide open. In the right eye there was no trabecular pigmentation, but moderate trabecular pigmentation was present in the left eye. The optic disc of the right eye was normal; that of the left eye showed partial excavation. The visual field of the left eye was constricted to within 5 degrees.

Case 7 (right). L. A., a colored woman, aged 43 years, had vision in the right eye of 20/20−2; in the left eye, 20/20−2. The anterior chambers were deep, the angles wide open. In the right eye there was a marked trabecular pigment ring; in the left, slight trabecular pigmentation. The optic disc of the right eye was completely excavated; that of the left showed the physiologic (type-2 Elschnig) excavation. The visual field of the right eye had a large arcuate scotoma above; that of the left was normal.

Case 8 (left). A. F., a colored woman, aged 73 years, had vision in the right eye of 20/20; the left was amaurotic. The anterior chambers were moderately deep; the angles wide open, with heavy trabecular pigmentation in both eyes. The disc of the right eye was normal; that of the left shallow, with complete excavation. The visual field of the right eye showed an upper nasal step.

Case 9 (right). W. E., a colored man, aged 55 years, had vision in the right eye of 20/20−; that in the left sufficed to count fingers at two feet. In the right eye the anterior chamber was of moderate depth, the angle was wide open, and there was a partial trabecular pigment ring. The left eye had a shallow anterior chamber (after trephining operation), multiple postoperative, peripheral anterior synechias, and prolapse of the ciliary processes into the trephine hole. There was complete glaucomatous excavation of both optic discs. The fields showed on the right a constriction above and nasally; on the left, only a temporal island.

Case 10 (right) and *case 11* (left). M. K., a white woman, aged 70 years, had vision in the right eye of 20/200; in the left, 20/200. The anterior chambers were moderately deep, the angles wide open, and there was heavy trabecular pigmentation in both eyes. The optic discs were partially excavated, and there was senile macular degeneration. An upper nasal step was present in both visual fields.

Case 12 (left). M. M., a white woman, aged 66 years, had vision in the right eye of 20/30; in the left eye, 20/30. The anterior chambers were of moderate depth, the angles wide open, and both eyes had a trabecular pigment ring. Discs and fields were normal. Spontaneous ocular tension was 37 mm. Hg (Schiötz).

Case 13 (right). J. D., a white woman, aged 68 years, had vision in the right eye of 20/30; in the left eye, 20/30. The anterior chamber of the right eye was slightly shallow, the angle open, and there was no trabecular pigmentation. The lens showed incipient cataract, and the disc a partial glaucomatous excavation. The

field had a Roenne scotoma. The left eye had a deep anterior chamber, an open angle except for postoperative adhesions from the 4:30- to the 6:00-o'clock position, and surgical aphakia. The field was normal. Tension in the right eye, repeatedly taken, ranged between 28 and 32 mm. Hg.

Case 14 (left). R. E., a white woman, aged 53 years, had vision in the right eye of 20/70+2; left, vision was 20/200+2. The anterior chambers were moderately deep, the angles wide open, without trabecular pigmentation. Incipient cataract was evident in both eyes. The disc of the right eye had physiologic (type-1 Elschnig) excavation; of the left, glaucomatous excavation. The visual field of the right eye was normal, that of the left showed a nasal step. Spontaneous tension was 35 mm. Hg.

Case 15 (left). C. D., a white woman, aged 60 years, had vision of the right eye of 20/50; of the left, 20/70. The anterior chambers were moderately deep, and the angles wide open, without trabecular pigmentation. The disc of the right eye showed physiologic (type-2 Elschnig) excavation; that of the left, partial glaucomatous excavation. The visual field of the right eye had no glaucomatous defects; that of the left was constricted nasally for 2/1,000. Spontaneous tension in the left eye was 37 mm. Hg.

Results*

In the patients of our series the greatest rise in ocular tension that was observed while they were under the influence of mydriatics was 13 mm. Since the intraocular pressure at the end of the observation period was usually on the downgrade or had leveled off, it is unlikely that any great increase of intraocular pressure occurred during the night following the instillations. The next morning the eyes that were under the influence of homat-

TABLE 1

THE FLUCTUATIONS OF THE INTRAOCULAR PRESSURE WHICH OCCURRED IN THE GLAUCOMATOUS EYES DURING THE CONTROL PERIOD

Case No.	T_0	T_1-T_0	T_2-T_0	T_3-T_0	T_n-T_0
1	29	0	+2	+2	+ 2
	27	+2	+2	+2	+ 4
2	27	0	+2	+4	+ 4
	23	+2	+2	+2	+ 6
3	52	−7	0	0	− 3
	49	−4	−4	−4	+ 3
4	45	−6	−3	−3	0
	42	0	0	0	0
5	31	0	−2	−2	+ 2
6	33	0	0	0	
7	27	0	−4	0	+15
	31	−2	−2	−2	+14
	33	−4	0	−6	0
8	29	−2	−2	−4	
	27	0	−2	−2	+ 6
9	33	−2	−4	−2	+ 3
	29	−4	−2	−2	+ 4
10	27	−2	0	0	
	27	0	0	0	
11	23	0	−2	−2	
	20	0	0	0	
12	19	+4	+4	+1	
13	23	0	−2	−2	
14	29	0	0	0	
15	31	−4	−4	−4	− 2
Averages		−1.2	−1.0	−1.2	

* The following abbreviations have been used in the tables:
T_0 signifies the tonometric reading obtained at the beginning of each observation period.
T_1, T_2, and T_3 designate the tonometric readings obtained one, two, and three hours, respectively, after the last instillation, or after T_0.
T_n designates the tonometric reading obtained at about 8:30 a.m. the following day.
F_p designates the greatest fluctuation of the width of the pupil observed during the three-hour periods.

TABLE 2

THE FLUCTUATIONS OF THE INTRAOCULAR PRESSURE AND OF THE WIDTH OF THE PUPIL WHICH OCCURRED IN THE GLAUCOMATOUS EYES WHILE UNDER THE INFLUENCE OF HOMATROPINE

Case No.	T_0	T_1-T_0	T_2-T_0	T_3-T_0	F_p
1	36	+ 3	+ 6	0	−0.5
2	36	+ 3	0	− 5	+0.5
3	45	0	+11	+ 4	+1.5
4	42	+ 3	+ 3	0	+2.0
5	31	+ 8	+11	0	+4.0
	31	+11	+ 5	+ 2	+2.0
6	31	+10	+ 5	+ 2	+3.5
	29	0	+ 4	+ 7	+2.5
7	36	+ 3	+13	0	+1.0
8	27	+ 9	+ 9	+12	+2 5
9	25	0	+ 4	+ 2	+1.5
	27	+ 4	+ 2	+ 4	+0.5
10	23	+ 4	+ 6	+ 8	+3.5
	25	+ 6	+ 6	+ 6	+2.0
	25	+ 6	+ 6	+ 6	−0.5
11	21	+ 4	+ 6	+ 4	+3.0
12	23	− 4	− 3	0	+1.5
	17	+ 4	− 1	0	+1.0
13	21	+ 6	+ 6	+ 4	+4.5
14	27	+ 4	0	− 2	+1.5
	29	+ 2	− 4	+ 2	+1.5
15	25	0	+ 4	+ 6	+2.0
Averages		+ 3.9	+ 4.5	+ 2.8	+1.9

ropine or homatropine plus paredrine showed tonometric readings not essentially different from those obtained on the control days. If paredrine had been instilled the day before, the morning readings were consistently lower than on control days, an observation reported by other authors also.

Many of the fluctuations of the tonometric readings observed on the control days, as well as while the eyes were under the influence of mydriatics, were less than 5 mm., and may have been partly or entirely due to technical errors. Such "pseudofluctuations," if due entirely to experimental errors, would be expected to occur in both plus and minus directions, whereas consistent plus or minus fluctuations, however small, probably indicated a corresponding change in intraocular pressure. Thus the fundamental question appeared to be that of consistency or inconsistency of the data.

A study of the tables shows a fair degree of consistency from case 5 on, whereas the eyes in cases 1 to 4 acted rather erratically. The fact that the vision of these eyes was very poor and the fixation

TABLE 3

THE FLUCTUATIONS OF THE INTRAOCULAR PRESSURE AND OF THE WIDTH OF THE PUPIL WHICH OCCURRED IN THE GLAUCOMATOUS EYES WHILE UNDER THE INFLUENCE OF PAREDRINE

Case No.	T_0	T_1-T_0	T_2-T_0	T_3-T_0	F_p
1	36	+ 3	+6	− 5	+3.0
2	42	− 6	0	−11	+2.5
3	42	− 3	+3	+ 7	+2.0
4	39	− 3	+3	0	+2.0
5	31	0	+2	+ 2	+3.0
	29	− 2	−2	− 2	+1.5
	36	+10	+6	− 3	+2.0
6	29	0	+2	+ 7	+4.0
	33	+ 3	+3	+ 3	+3.0
7	31	+ 2	+2	+ 2	+2.5
	36	0	+3	0	+4.5
8	29	+ 2	+4	+ 7	+2.0
9	23	+ 4	+6	+ 6	+2.5
	25	+ 2	+4	+ 2	+3.0
10	27	0	+2	+ 2	+3.5
	20	+ 3	+3	+ 3	+2.5
11	21	+ 4	+4	+ 4	+2.5
12	19	0	+4	+ 4	+2.0
13	21	+ 4	+2	0	+2.0
14	23	+ 4	+8	+ 6	+2.5
	27	0	+2	+ 2	+3.0
15	31	− 6	−2	− 4	+2.0
Averages		+ 1.0	+3.0	+ 1.5	+2.6

most uncertain made the tonometric readings on these eyes less accurate than in the eyes in cases 5 through 15. However, even considering the gross inaccuracy of the readings in the first four eyes, it is reasonably certain that no gross alteration of the intraocular pressure occurred while these eyes were under the effect of mydriatics. The data obtained on the eyes in cases 5 through 15 possessed the quality of consistency to a high degree.

During the control period the tonometric readings usually remained fairly stationary at a level slightly below the initial reading.

TABLE 4

THE FLUCTUATIONS OF THE INTRAOCULAR PRESSURE AND OF THE WIDTH OF THE PUPIL WHICH OCCURRED IN THE GLAUCOMATOUS EYES WHILE UNDER THE INFLUENCE OF HOMATROPINE PLUS PAREDRINE

Case No.	T_0	T_1-T_0	T_2-T_0	T_3-T_0	F_p
1	33	0	− 2	− 2	+1.0
2	31	0	0	− 4	+1.0
3	67	−6	+ 4	+ 4	+3.0
4	56	0	+11	0	+3.0
5	31	+5	+11	+11	+2.0
	33	0	+ 3	− 2	+3.0
6	36	+3	0	+ 6	+5.5
	36	+6	+ 6	+13	+2.0
7	27	+6	+ 9	+12	+5.0
8	20	+3	+ 7	+ 9	+1.0
9	23	+4	+10	+ 6	+2.5
	27	+2	+ 4	+ 7	+1.0
10	23	+4	+ 6	+ 4	+3.0
11	17	+6	+ 6	+10	+3.0
12	20	+5	+ 9	+ 9	+2.5
13	21	+9	+ 6	+ 4	+1.0
14	23	+4	+10	+ 8	+2.0
15	25	+6	+ 7	+ 6	+1.5
Averages		+3.2	+ 5.4	+ 5.6	+2.4

TABLE 5

THE FLUCTUATIONS OF THE INTRAOCULAR PRESSURE WHICH OCCURRED IN THE GLAUCOMATOUS EYES DURING THE DRINKING TEST

Case No.	T_0	Readings 20 minutes apart				
1	33	+ 6	+16	+16		
2	31	+ 2	+14	+14		
3	61	+ 6	+ 6	+10	+ 6	
	49	+12	+ 7	+ 3	0	
4	61	+ 6	0	+16	+ 6	
	45	+11	+ 7	+ 4	+ 4	
5	31	+ 5	+ 5	+ 8		
6	31	+ 5	+11	+ 7		
7	33	+ 6	+ 9	+ 6	− 2	
8	29	+ 2	+10	+10	+ 7	
9	29	+ 2	+ 4	+ 7		
10	23	+10	+13	+13	+ 8	
11	20	+ 9	+ 7	+ 9	+ 7	
12	20	+ 5	+ 7	+ 1	0	
	17	+10	+10	+10	+10	
13	20	+ 3	+ 7	+ 7	+ 9	+1
14	20	+ 3	+ 3	+ 3	0	
	23	+ 2	+ 2	+ 2	0	
15	31	+ 5	+ 5	+ 8	+ 5	
Averages		+ 5.8	+ 7.5	+ 8.1	+ 4.3	

Under all three mydriatics the tonometric readings tended to be higher than the initial reading. This increase was most pronounced under homatropine plus

TABLE 6

COMPARISON BETWEEN GLAUCOMATOUS AND CONTROL EYES WHILE UNDER HOMATROPINE + PAREDRINE

	Averages and greatest fluctuations observed		
	T_1-T_0	T_2-T_0	T_3-T_0
Controls	+1.3 $^{+5}_{-2}$	+1.2 $^{+4}_{-2}$	+0.7 $^{+3}_{-2}$
Glaucomatous eyes	+3.2 $^{+9}_{-6}$	+5.4 $^{+11}_{-2}$	+5.6 $^{+13}_{-}$

paredrine and smallest under paredrine alone. In the case of homatropine alone the increase in pressure seemed to occur a little earlier than after the use of paredrine alone or when combined with paredrine. Three hours after the instillations a trend toward return to the initial reading became noticeable.

TABLE 7

AVERAGES OF FLUCTUATIONS OBSERVED IN GLAUCOMATOUS EYES

Medication	T_1-T_0	T_2-T_0	T_3-T_0
Control	−1.2	−1.0	−1.2
Homatropine	+3.9	+4.5	+2.8
Paredrine	+1.0	+3.0	+1.5
Hom.+Par.	+3.2	+5.4	+5.6
Drinking test	+5.8, +7.5, +8.1	+4.3	

The foregoing fluctuations of the tonometric readings occurred with sufficient consistency to warrant the interpretation of their representing actual increases in intraocular pressure.

Plotting of the increase in pupillary size against the increase in intraocular pressure revealed no relationship between the two factors. A study of the relationship between the increase in intraocular pressure and the degree of cycloplegia was attempted, but proved impractical because of the advanced presbyopic state of the great majority of the patients.

As was stated in the introduction, the area of the corneoscleral trabeculum that was gonioscopically visible showed no variation throughout this study.

CONCLUSIONS

Although no claim is made that in our series of 15 eyes all varieties or forms of so-called primary wide-angle glaucoma are represented, the group seems to be comprehensive as far as the gonioscopic picture and the stages of glaucoma are concerned. Thus it appears certain that in primary wide-angle glaucoma the intraocular pressure is not grossly influenced by the administration of mydriatics. On the other hand, we believe we have shown that a slight increase of the intraocular pressure does occur. Such increase, while of no practical importance, is greatest under homatropine plus paredrine and smallest under paredrine alone. Since paredrine usually exhibited the strongest mydriatic and the weakest pressure-elevating effect, it seemed to be the ideal mydriatic for use in cases of wide-angle glaucoma.

The increases in the tonometric reading were not associated with significant changes in ocular rigidity and therefore probably represented true elevations of the intraocular pressure. The mechanism of these elevations can at this time be only a matter of speculation.

The response to mydriatics of early so-called primary wide-angle glaucomas is, as a rule, less constant and less pronounced than the response to the drinking test of Marx and Schmidt. The latter test is, therefore, of greater practical diagnostic value than is the former. By the same token, a negative response to mydriatics of an eye suspected of wide-angle glaucoma is of considerably less diagnostic value than is a negative response to the drinking test.

REFERENCES

[1] Sugar, H. S. Amer. Jour. Ophth., 1941 v. 24, Aug., p. 851.
[2] Gradle, H. S., and Sugar, H. S. Amer. Jour. Ophth., 1940, v. 23, p. 1138.
[3] ———. Idem. 1135.
[4] Koellner, H. Arch. f. Augenh., 1921, v. 88, p. 58.
[5] Streiff, E. B. Klin. M. f. Augenh., 1937, v. 98, p. 504.
[6] Ohm, G. Arch. f. Ophth., 1936, v. 135, p. 537.
[7] Gilde, I. Doctor's dissertation, Koenigsberg, 1937.

METASTATIC ORBITAL INFECTION

Report of a case*

Frank E. Burch, M.D.
Saint Paul, Minnesota

Retrobulbar abscess of metastatic origin, even in the presence of septicemia, often must be diagnosed clinically on the basis of exclusion of other etiologic factors. Birch-Hirschfeld,[1] in his recent review of the course and therapy of orbital phlegmon, concluded that 58.9 percent of the reported cases were caused by inflammation of the nasal accessory sinuses, and that in adults the frontal sinus and, in children, the ethmoids were the most frequent sites of origin. The pertinent literature, therefore, has appeared for the most part in otolaryngologic publications.

It is of interest to note that the earlier authors not infrequently mentioned the occurrence of so-called metastatic ophthalmia, or *intra*ocular infection, caused by septicemia in association with the acute exanthemata, puerperal infection, and typhoid fever as well as with other inflammatory and febrile diseases the incidence of which currently is low or minimal. Wagenmann,[2] for example, reported a case of bilateral streptococcic panophthalmitis of metastatic origin, and Holmes Spicer[3] cited an instance of metastatic abscess of the optic papilla following staphylococcic furunculosis of the buttocks. The reports of endogenous intraocular infection that originated from remote foci or from septicemia still are far more numerous than those of true retrobulbar abscess, which are relatively uncommon.

It is not unlikely that some of the reported cases of pseudotumor of the orbit (although the condition rarely is acute) may have occurred subsequent to endogenous infection that resulted in low-grade thrombophlebitis, localized granulomatous infiltration, and moderate cellulitis. Benedict[4] considered this possibility and stated: "The finding of focal infection elsewhere in the body, preceding or accompanying the signs of orbital tumor, also makes the infectious character of the condition seem probable." The process ordinarily subsides without abscess formation; however, many have been explored surgically without obtaining evidence of tumor tissue or abscess débris. Spontaneous subsidence has occurred ultimately as the result of roentgen or foreign-protein therapy as well as after surgical interference.

The course of events confirms the concluding diagnosis of pseudotumor of the orbit. Minor sequelae may ensue, but partial or complete optic atrophy occasionally does occur. It must be inferred that some of these "pseudotumors" are nonpyogenic, metastatic infections capable of inducing local inflammatory changes of varying degree in the orbit. Clinical evidence of thrombosis of orbital veins may present itself in some cases, whereas in others there may be visualized small foci of purulent infection that has been walled-off and reabsorbed to result in the infiltrative granulomatous tissues found in biopsy specimens. In two such instances within the author's experience subacute orbital cellulitis developed; one of these exhibited no abscess or tumor on surgical exploration, and the other slowly receded after a long period of anxious

*From the Department of Ophthalmology, University of Minnesota. Read at the seventy-eighth annual meeting of the American Ophthalmological Society, Hot Springs, Virginia, June 1-3, 1942.

uncertainty as to diagnosis and prognosis. In one other instance, which followed a furuncle above the bridge of the nose, both orbits were intensely involved. The temperature and the leucocyte counts indicated definite infection, but needle exploration yielded negative results. The exophthalmos ultimately subsided, leaving a residual optic atrophy of one eye and visual acuity of 6/60, because of partial optic atrophy, in the other.

The origin of retrobulbar phlegmon usually is endogenous when the condition is not associated with erysipelas, lid or lacrimal infection, inflammation of the adjacent nasal accessory sinuses, periostitis, or penetrating wounds of the orbit. As Fuchs[5] has stated: "Retrobulbar inflammation may originate from metastasis in pyemia, typhus, scarlatina, measles. suppurative meningitis, influenza, furunculosis, et cetera." It is open to question whether the process may begin as a thrombosis, or if thrombosis of the orbital veins follows a cellulitis of endogenous origin. The orbital phlegmon may, as suggested by Fuchs,[6] ". . . lead to thrombosis of sinus cavernosus, but the reverse may also take place—the thrombus proceeds from a thrombosed cavernous sinus and, followig this suppuration, proceeds into the orbit."

Metastasis may originate from many sources. Sattler[7] reported a case in which an abscess within the muscle cone developed in the orbit of the right eye 48 hours after incision of an abscess complicating moniliasis (thrush) of the buccal mucosa. The exophthalmos and all ocular symptoms subsided completely 10 days after exploratory incision and drainage of the retrobulbar abscess. Metastatic infection, however, subsequently occurred in the femoral vein and, after three weeks of illness, death from generalized septicemia ensued. Mackay[8] observed two cases in which the causative organism, as diagnosed by examinations of the blood, was the anthrax bacillus. J. A. McCaw[9] reported a case of "Thrombophlebitis of retro-orbital veins caused by interstitial gingivitis" in which the negative blood cultures precluded the septicemic origin. The patient, however, had a typical pyemic temperature, with chills, and it is possible to infer that the laboratory examinations, as regards the blood cultures, may have been faulty. The case appeared to be one in which a probable thrombophlebitis of both orbits had occurred, but this condition did not extend to the cavernous sinus and subsided after collateral circulation was established. The orbital condition followed acute suppurative pericementitis. No exploration was done; however, the outcome was fortunate, since the patient was able to overcome the infection without abscess formation.

M. Tauferoon-Karaskova[10] observed a metastatic orbital abscess that developed during the third week of an attack of typhoid fever, and from which typhoid bacilli were obtained on culture. Chronic periostitis developed secondarily, but this was treated successfully with typhoid vaccine and roentgen rays. M. L. Genét[11] reported two cases of orbital thrombosis following furuncles of the upper face. Unilateral phlegmon developed in one case four days after the appearance of a furuncle of the nose. The other orbit was involved similarly on the second day after the first orbital infection was observed, and the patient expired four days later. In the second case exophthalmos began on the fifteenth day following the appearance of a furuncle of one lower eyelid. Remission occurred, but there ensued metastases in the parotid glands, many joints, and in the lungs (pneumonia). The patient recovered from these manifestations of his infection but, after eight days of normal temperature, the exophthalmos recurred. In his discussion the

author made the comment that orbital thrombosis need not necessarily eventuate in cavernous-sinus thrombosis, but that the condition may remain localized. Bhaduri[12] cited a case of metastatic orbital abscess following abscess of the back. Drainage of the latter resulted in no change in the typically septic temperature curve. Blood cultures were not reported. Staphylococcus aureus was cultured from both the original infection and the orbital abscess. The exophthalmos and optic neuritis had disappeared 12 days after exploration and drainage.

Gamble[13] believed that when bacteremia causes orbital infections, "The process begins as a periostitis, but because the patient is seriously ill it rapidly spreads into the retrobulbar tissues and forms a true orbital abscess." One readily may agree with him that this mechanism of production by periosteal invasion probably could follow in cases originating from exanthemata with purulent rhinitis, but may doubt its probability when phlegmon occurs with bacteremia from puerperal sepsis, pneumonia, or other remote foci.

Ruhberg[14] recently reported a series of metastatic brain abscesses secondary to remote infections that had subsided or improved. In 33 percent of his series of cases the abscess had originated from, and usually quite a period after, pulmonary causes; namely, empyema, bronchiectasis, bronchopneumonia, or lung abscess in the order of frequency mentioned. The relative incidence was much higher in Sharstein's series (quoted by Ruhberg). Whether the pulmonary involvement commonly is antecedent appears to deserve consideration. In the case reported here the patient immediately suffered alarming pulmonary complications following acute septicemia of staphylococcic origin, and the orbital involvement occurred during the pulmonary empyema. Frequent examinations by Dr. Lawrence R. Boies over many weeks revealed no evidence of sinus involvement. Roentgenographic evidence was also negative.

Report of case

R. A. S., a white man, aged 39 years, developed a furuncle just within the left ala of the nose on or about September 14, 1941. This extended rapidly as a diffuse induration of the nose, with edema of the face and of both eyelids. The patient was profoundly toxic when admitted to the Abbott Hospital, Minneapolis, on September 18, 1941, under the service of Dr. Jay C. Davis. In addition to the local infection, he complained of severe, deep thoracic pain on respiration. There was no demarcation of the facial induration. Both eyelids were closed completely, and the conjunctivas were chemotic. The oral temperature was 103°F. Examination of the formed elements of the blood revealed an increase in the leucocyte count to 32,200 per c.mm., while differentially, the polymorphonuclear cells and the lymphocytes were found to be 82 and 18 percent, respectively, on admission. The nasal infection and the facial swelling subsided promptly after a few days of local treatment.

On the day after admission Dr. Davis discovered a basilar pulmonary infiltration. This was confirmed roentgenographically. Type V pneumococcus was found in large numbers in the sputum. Staphylococcus aureus was cultured later from both lungs. Smears from the nasal furuncle and from other small areas on the nose made on September 20, 1941, and cultures from the same source and from the blood, revealed a strain of hemolytic Staphylococcus aureus. The blood cultures on September 21st exhibited 264 colonies per cubic centimeter. Five days later these became negative but on the next three succeeding days there was one

colony each. There were 35 colonies per c.c. on October 1st, after which date all cultures essentially were negative throughout except for an occasional one which was nonpathogenic on coagulase test and probably was due to contamination.

Treatment was heroic, beginning with sulfathiazole until a rash and toxic symptoms occurred. The dosage was as high as 32 gm. daily, because of the large number of colonies in the blood cultures; however, there was a very high fluid intake and output. A very small amount of the drug was acetylated. Antipneumococcus serum, type V, and staphylococcus antitoxin also were administered. Sulfadiazine later was given by mouth in doses of 6 to 7 gm. daily. The sulfa blood level was maintained at an average of 10 mg. per c.c. until October 11th, when the leucocyte count decreased to 1,900 per c.mm., with no polymorphonuclear cells present. Leucopenia was controlled by cessation of the sulfa drugs (without the use of pentnucleotides), with an immediate rise in the white-cell count and the reappearance of neutrophilic cells. Empyema developed, necessitating aspiration and rib resection on October 7th on the right side, with drainage of three pockets and a closed drainage of a fourth pocket on the right side on November 6th. With repeated trocar aspirations the left side cleared. The temperature was typically septic, ranging from 101° to 105°F., and from 104° to 107°F. by rectum (fig. 1). Delirium was present over a period of five weeks. Resolution of the pneumonitic infiltration was fairly complete after four weeks, but repeated roentgenographic studies revealed the presence of a pus pocket in the pleura until December 15, 1941. Nine blood transfusions of 200 to 500 c.c. each were given during this period. Bacteriophage also was administered intravenously as well as in the pleural cavity, in appropriate amounts from October 3d to 25th. [This was supplied by Dr. Frank L. Meleney of New York.]

Exophthalmos of the left eye first was observed by Dr. Davis on October 8th, the day following rib resection. The veins of the lids were prominent. There was no definite impairment of ocular motility. Some fullness of the retinal veins was observed, but this might have been a concomitant of the generalized febrile reaction. A retrobulbar abscess was suspected. Dr. Lawrence Boies was able definitely to rule out clinical and roentgenographic evidence of any infection of the nasal accessory sinuses. An early, or beginning, cavernous-sinus thrombosis also was considered, but a distinct subsidence of the exophthalmos to almost normal during the following week, and the absence of any supporting cerebral signs made this diagnosis improbable. A slight conjunctival edema of the left eye became manifest on October 15th, and, five days later there was ocular pain; on the following day, exophthalmos recurred, with definite displacement of the left globe lateralward. There also was limitation of ocular motility of this eye together with diplopia on gazing to the right. The retinal veins were engorged, and there was one diopter of papilledema. The veins of the lids still were prominent. Cellulitis of the orbit, or a possible retrobulbar abscess, was considered by Dr. Davis as well as by Drs. Hewitt B. Hannah and John Curtin, who examined the patient on October 22d. The exophthalmos remained essentially stationary until October 27th, when there was a rapid increase in the proptosis, with progressively severe pain and fixation of the globe.

On my first examination, on November 11, 1941, the measurements with the Luedde exophthalmometer were 15 mm. for the right and 25 mm. for the left eye.

The nervehead was blurred, and there were approximately two diopters of papilledema together with fairly marked venous engorgement. A slightly increased resistance above the infraorbital notch led to exploration with a needle. About 3 cm. behind the orbital margin, 1.5 c.c. of thick pus was aspirated. An incision was made through the left lower lid; staphylococci were found in the smears. internal canthal ligament and out below through the first drainage opening. There was free drainage of creamy pus during the following three or four days. Metastatic infection, which, however, gradually subsided, manifested itself, with acute effusion and severe pain in the left ankle on November 18th. On December 1st there was pain that centered in the right hip. Roentgenographic examination revealed the presence of osteitis and bursitis over the right greater trochanter. After a few weeks of local treatment in conjunction with the resumption of sulfadiazine these evidences of metastatic infection disappeared, to reappear later in the hip.

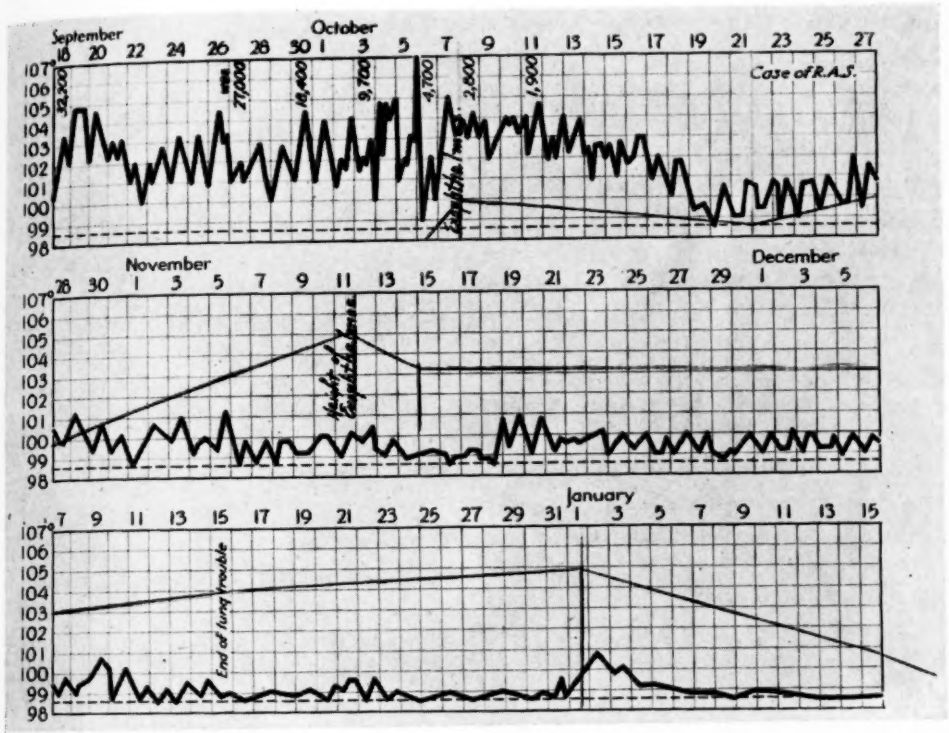


Fig. 1 (Burch). Temperature fluctuations in the course of a metastatic orbital infection.

The proptosis did not subside markedly, but during the succeeding six days the temperature became nearly normal. Dr. Boies was of the opinion that there was a definite thrombosis of the orbital veins, with abscess that probably had become sterile. On November 14th he inserted a hemostat through the incision, and at a depth of about 2 cm. encountered thick pus. A Penrose drain was inserted through an external incision above the

The primary drainage of the orbit from below was followed by a nearly stationary temperature curve over a period of one month, during which time there was a daily elevation to about

100°F. by mouth. There was no obvious change in the exophthalmos. By December 15th, the pulmonary infection had subsided entirely. The temperature then remained practically normal until January 1, 1942, but the proptosis persisted, with sufficient pain to require moderate doses of opiates. He was discharged to his home on December 23d, with persistent exophthalmos, very limited motility, but with normal vision until December 30th. On the following day there was exacerbation of the process together with marked increase of the papilledema. Hemorrhages were observed in the immediately adjacent retina. Central vision was lost. Exploration through the left upper lid with a coarse needle, on January 1st, revealed the presence of pus at a depth of approximately 4.5 cm., near the apex of the orbit on its nasal side. The patient again was hospitalized and, under pentathol sodium anesthesia, a Penrose drain was inserted from the upper, inner angle of the orbit and out through the original drainage below, after the abscess was located well behind the globe. Sulfadiazine therapy was resumed. After one week the exophthalmos began to diminish, the motility of the globe increased, and the discharge continued to be profuse for several days. On one of the dressings there was a slough that had all the appearances of venous tissue. Ten days after the operation the papilledema had nearly subsided. The proptosis gradually decreased, and after one month the exophthalmometer readings were 16 and 19 mm. for the right and the left eye, respectively. Diplopia persisted for three months but, on May 1, 1942, it was still present only in the extreme right upper field. There was no enlargement of the blind spot. Distance vision was 20/15, and the residual proptosis was 16 mm. for the right and 17 mm. for the left eye.

Discussion

There were obvious difficulties in arriving at a diagnosis in this case of extreme illness with both moderate and profound complications. Pseudotumor of the orbit, beginning cavernous-sinus thrombosis, thrombophlebitis of the orbital veins, orbital cellulitis, and orbital abscess were considered at different stages. The transitory proptosis that developed in the third week of septicemia, with pulmonary complications, and returned to normal for one week only to recur even after blood cultures had become negative, resulted in a very confusing clinical picture when considered in the presence of a subsiding temperature and developing metastases elsewhere together with the absence of nasal accessory sinus infection.

It is very difficult to draw a distinction between an orbital cellulitis due to endogenous infection from septicemia and one that has emanated from a neighboring infection, without considering the time element. If, as we have supposed, the retrobulbar abscess had its origin in a thrombophlebitis approximately three weeks after the primary local infection had healed, it is difficult to explain the recurrence, or exacerbation, only one week after the almost complete subsidence of the exophthalmos and the other ocular symptoms. O. V. Batson[15] stated that: "Experimental injections tend to confirm the view that true lymphatic tissue does not exist in the orbital tissues." It would seem probable, therefore, that a cellulitis that occurs subsequent to an infectious process in the orbital veins, but which undergoes regression, must become corrected, or healed, through the establishment of collateral circulation and the direct reparative action of leucocytic phagocytization; that the occurrence of meningitis or of cavernous-sinus throm-

bosis coincident with, or subsequent to, severe and acute orbital infections must extend either by contiguity or through the blood stream. Eagleton,[16] in discussing exophthalmos, stated: "Nature has provided a closed fascio muscular space in the orbit, referred to as the 'protective retrobulbar space,' which reacts uniquely to infection"; that "Proptosis follows primary phlebitic phlegmon," and that "the relief of localized orbital phlegmon within the cone should suffice to control the infection in a considerable number of cases and thus prevent its extension into the cavernous sinus."

The orbital process in the case reported here, evidently was walled-off or under local control, but at any time there might have occurred an extension backward of the thrombosis to the caverous sinus, with the usual fatal ending. The fact that cellulitis and phlegmon of the orbit developed after the severe pulmonary infection leads one to believe that, not unlike the incidence of brain-abscess formation from a similar origin, this might have been an instance of direct metastasis caused by empyema. Eagleton condemns the practice of blind operative exploration into the orbit, in the hope of finding pus, on the ground that it only accelerates the phlebitic infection converting the process into a fulminating lesion with a cavernous-sinus phlebitis. In this case it proved successful, and it is difficult to see how exploration with a coarse needle was anything but helpful in locating the site of the abscess, providing a lead for drainage, and eventually resulting in complete subsidence of the whole inflammatory process and restoration of vision. It is not improbable that the outcome would have been less fortunate if an extensive exploration had been made at an earlier date. This would appear to be true particularly with regard to a lesion so deeply situated and severely widespread, since extension of the process backward into the caverous sinus would have been facilitated thereby, unless there had occurred a fortuitous occlusion of the ophthalmic vein behind the focus of infection. If heparin had been administered prior to the remission of the morbid process, it would have been credited with the regression of the ocular symptoms, the exophthalmos, and other signs. It is obvious that sulfa therapy, as in other abscess formations, was inadequate without the adjunct of surgical drainage, but it is problematic whether chemotherapy contributed largely to localizing and controlling the orbital infection. It undoubtedly was an important factor, and it is probable that this form of therapy was responsible for sterilizing the local process, which, after the period of regression, underwent renewed activity because of the presence of residual infective organisms that caused a localized cellulitis and resulted in an abscess for which drainage was required.

424 Hamm Building.

References

[1] Birch-Hirschfeld, A. Clinical course and therapy of orbital phlegmon. Auerbach Jubilee Vol., 1935, p. 84.

[2] Wagenmann, A. Arch. f. Ophth., 1887, v. 33, p. 147.

[3] Spicer, H. Metastatic infection of the eye. Trans. Ophth. Soc. United Kingdom, 1907, v. 27, pp. 230-245.

[4] Benedict, W. L. Inflammatory pseudotumor of the orbit. Arch. of Ophth., 1923, v. 52, November, p. 582.

[5] Fuchs, Ernst. Textbook of ophthalmology. Ed. 10 (English), Salzmann-Brown, 1933, p. 535.

[6] ——. Ibid.

[7] Sattler, E. Nach Schwämmchen (Soor) aufgetretener retrobulbärer Abscess. Deutsche Zeit. f. Chir., 1927, v. 205, p. 361.

[9] Mackay, G. Inflammatory affections of the orbit. Trans. Ophth. Soc. United Kingdom, 1928, v. 48, p. 40.
[9] McCaw, J. A. Thrombophlebitis of retro-orbital veins caused by interstitial gingivitis. Colorado Med., 1922, v. 19. July, pp. 138-142.
[10] Tauferoon, M. Karaskova. Deux cas d'abcés de l'orbite. Ann. d'Ocul., 1931, v. 168, p. 943.
[11] Genêt, M. L. Deux cas de thrombophlebite orbitaire. Ann. d'Ocul., 1931, v. 168, p. 398.
[12] Bhaduri, B. N. Unilateral inflammatory exophthalmos (due to orbital abscess) as metastasis in pyemia. Calcutta Med. Jour., 1939, v. 36, July, p. 51.
[13] Gamble, R. C. Orbital abscesses. Arch. of Ophth., 1937, v. 18, Oct., p. 633.
[14] Ruhberg, G. Metastatic brain abscesses. Minnesota Med., 1942, v. 25, Feb., p. 108.
[15] Batson, O. V. The lymphatics of the orbit. Arch. of Ophth., 1938, v. 19, p. 1031.
[16] Eagleton, W. P. Exophthalmos from surgical diseases especially as to involvement of protective retrobulbar space. Arch. of Ophth., 1935, v. 14, July, p. 1.

THE ROLE OF IRON, COPPER, ZINC, AND MANGANESE IN THE METABOLISM OF THE OCULAR TISSUES, WITH SPECIAL REFERENCE TO THE LENS*

F. WARREN TAUBER AND ARLINGTON C. KRAUSE, M.D.
Chicago

The relationships of the inorganic substances in the ocular tissues have been ably investigated in the past by Salit and O'Brien, Burdon-Cooper, and Fisher. These investigations have been chiefly concerned with the substances that are directly related with osmotic equilibrium, and with the irritability and integrity of the cell. The present report is concerned chiefly with the trace elements of the tissues. These trace elements represent less than 0.2 percent of the inorganic material present in the tissue. Burdon-Cooper[1,2] failed to demonstrate conclusively the presence of iron, zinc, and manganese in the ash from pig, ox, and cataractous human lenses. This is not surprising, since, in a spectrographic analysis of ash, the trace elements may be obscured by a preponderance of calcium and phosphorus. That iron, copper, manganese, and zinc are of utmost importance to the cellular metabolism has been demonstrated only in the past decade. The present research was undertaken to establish the presence and relative proportions of these trace elements in the ocular tissues. If in the discussion seemingly unusual examples of the trace elements are used, they are used not to confuse, but to demonstrate the fundamental importance of these substances as judged by their wide distribution and diversity of reactions.

* From the Division of Ophthalmology, Department of Surgery, University of Chicago.

EXPERIMENTAL

Eyes from freshly slaughtered cattle were dissected and the tissues separated.

Iron was determined by the method of Jackson.[3] Samples containing 20 to 50 micrograms of iron were wet ashed with redistilled nitric acid. The distillation of the nitric acid was a necessary precaution to prevent addition of iron in appreciable amounts to the determination. This was especially true for lens, for lens has an iron content lower than that of most analytical reagents. Concentrated ammonium hydroxide was added to the neutral point, using brom-phenol blue as

TABLE 1
IRON CONTENT OF THE OCULAR TISSUES

	Micrograms per 100 grams Wet Tissue			Micrograms per 100 grams Dry Tissue		
	Minimum	Maximum	Average*	Minimum	Maximum	Average
Conjunctiva	243	300	273	900	1,200	1,090
Cornea	208	296	257	1,000	1,380	1,160
stroma	166	220	197	720	1,000	890
epithelium	552	680	616	2,200	2,720	2,460
Sclera	266	420	355	1,000	1,600	1,350
Iris	298	392	338	1,180	1,560	1,360
Choroid	1,250	3,020	1,880	5,000	12,000	7,600
Aqueous humor	11	22	16	660	1,200	870
Vitreous humor	6	20	12	306	1,020	615
Lens	25	40	32	67	107	86
Retina	330	440	380	3,740	3,620	3,120
Optic nerve	298	376	335	1,160	1,420	1,300

* Average five determinations.

an indicator. The solution was saturated with hydrogen sulfide and the precipitate was removed on a Jena filter. The precipitate was dissolved in 1-N hydrochloric acid. The solution was boiled to remove hydrogen sulfide, neutralized, and adjusted to volume. To an aliquot, acetate buffer, hydroquinone, and a solution of α, α' dipyridyl were added. The pink color that developed was measured in a Pulfrich photometer with the use of an S-52 filter. To a sample of lens of known iron content 32 micrograms of iron were added and 30.8 micrograms were recovered by the above procedure. Blank determinations usually gave values of 2 to 3 micrograms of iron.

Table 1 gives the iron content of the ocular tissues.

Copper was determined by the method of Elvehjem and Lindow.[4] Samples of tissue containing 50 to 200 micrograms of copper were ashed in a muffle furnace at low red heat. The residue ash was extracted with hydrochloric acid. The solution was filtered, neutralized, and made up to volume. An aliquot was treated with glacial acetic acid, a solution of

TABLE 2
COPPER CONTENT OF OCULAR TISSUES

	Micrograms per 100 grams Wet Tissue			Micrograms per 100 grams Dry Tissue		
	Minimum	Maximum	Average*	Minimum	Maximum	Average
Conjunctiva	134	212	183	535	850	734
Cornea	135	234	176	500	874	652
stroma	108	184	131	408	680	485
epithelium	360	553	455	1,730	2,640	2,180
Sclera	144	250	221	575	1,000	885
Iris	183	410	318	732	1,640	1,270
Choroid	290	424	339	1,160	1,690	1,360
Vitreous humor	18	34	26	990	1,760	1,350
Lens	115	241	169	322	677	474
Retina	121	395	264	1,030	3,360	2,240
Optic nerve	295	475	349	895	1,445	1,045

* Average five determinations.

TABLE 3

MANGANESE CONTENT OF THE OCULAR TISSUES

	Micrograms per 100 grams Wet Tissue			Micrograms per 100 grams Dry Tissue		
	Minimum	Maximum	Average*	Minimum	Maximum	Average
Conjunctiva†	6.9	11.4	9.9	23	37	28
Cornea	9.4	12.5	11.3	37	49	44
stroma	5.2	11.7	8.2	20	46	32
epithelium	39.8	55.0	46.1	198	276	231
Sclera	7.8	13.3	9.0	25	42	32
Iris	21.4	28.6	24.3	79	118	92
Choroid	17.4	32.0	20.8	59	109	71
Vitreous humor	1.9	4.2	3.1	93	206	148
Lens	14.1	21.8	17.9	41	63	52
Retina	24.4	39.0	31.8	200	319	260
Optic nerve	21.8	31.0	26.2	83	119	101

* Average five determinations; † three determinations.

potassium thiocyanate, and finally pyridine. A measured volume of chloroform was added, and after thorough shaking and settling the colored chloroform layer was withdrawn and the color value determined on the Pulfrich photometer with an S-43 filter. Copper added to a sample of lens of known copper content could be recovered quantitatively.

Table 2 gives the copper content of the ocular tissues.

Manganese was determined by the method of Wiese and Johnson,[5] and the method of Skinner and Peterson[6] was used for confirmatory tests. Samples weighing from 20 to 40 grams were ashed in a muffle furnace. The ash was extracted with nitric acid and the extract evaporated. Nitric acid was added to the dry extract and then evaporated. This procedure was repeated several times to remove chlorides. The residue was finally extracted with 20-percent nitric acid. After adding sodium bismuthate the mixture was boiled, cooled, and then filtered through asbestos into a tube containing a 1-percent benzidine solution. A yellow-green color developed, and at the end of five minutes the color was measured in the Evelyn colorimeter.

TABLE 4

ZINC CONTENT OF THE OCULAR TISSUES

	Micrograms per 100 grams Wet Tissue			Micrograms per 100 grams Dry Tissue		
	Minimum	Maximum	Average*	Minimum	Maximum	Average
Conjunctiva†	127	202	164	510	808	658
Cornea	194	222	211	740	845	802
stroma	96	142	117	370	546	443
epithelium	316	414	376	1,490	1,970	1,800
Sclera	167	209	177	550	690	585
Iris	346	430	404	1,230	1,530	1,440
Choroid	190	241	220	724	918	838
Vitreous humor	25	42	29	1,220	2,060	1,420
Lens	181	328	280	526	955	814
Retina	266	322	299	2,170	2,620	2,450
Optic Nerve	202	291	241	810	1,170	965

* Average of five determinations; † three determinations.

The manganese content is given in table 3.

The method of Caughey, Holland, and Ritchie[7] for zinc was found satisfactory. Samples of tissue were chosen so that the ash would contain 10 to 20 micrograms of zinc. The tissue was ashed in a muffle furnace at low red heat. The ash was dissolved in dilute hydrochloric acid and the dithizone reagent added. The mixture was shaken with carbon tetrachloride and the red-purple zinc salt was dissolved in the carbon-tetrachloride layer. The carbon tetrachloride was separated, diluted to volume, and the color value estimated in a Pulfrich photometer with an S-53 filter.

As a check on the zinc method the test solutions were accumulated, evaporated, and finally ashed. The ash was dissolved in dilute acetic acid, and this solution was treated with hydrogen sulfide. The zinc sulfide was collected on a sintered funnel, washed, dried, and weighed. The zinc recovered in this manner was equivalent to 82 percent of the color value. Zinc determined by the wet-ash method gave slightly higher results.

The zinc content is given in table 4.

Discussion

Iron is an important element in the mechanism of biologic oxidations. It is a constituent of hemoglobin, of cytochrome, of catalase, and other oxidizing enzymes. Loosely bound ferrous iron has been suggested by Zuckerkandl[8,9] as a necessary component in glycolysis. He reports that α, α' phenanthroline forms stable ferrous complexes and inhibits alcoholic and lactic-acid fermentation, whereas, α, β' phenanthroline forms no such complexes and does not inhibit glycolysis. Ustvedt[10] was unable to confirm these observations in the case of muscle glycolysis. The possibility of α, α' phenanthroline having a direct and specific action should be given some consideration. The action of α, α' phenanthroline on lens respiration would be of interest, for the lens has an extremely low iron content and Weekers[11] reports that the greater part of the lens carbohydrate metabolism is the breakdown of glucose to lactic acid. While Burdon-Cooper[1,2] reported the absence of iron in the ash of individual lenses, he was confident that iron was present in traces. The low iron content of lens (25 to 40 micrograms per 100 gm. fresh lens) is not surprising, since the cellular portion of the lens is confined to a few layers on the anterior surface. The relation of cellular structure to iron content is shown even better in the cornea. The epithelial layer has three times the amount of iron that the stroma has. The choroid is much higher in iron than the iris. The high iron content of the choroid may possibly be accounted for by occluded blood, although the tissues were washed as free of blood as was practical. The possibility of the pigment of the choroid and of the iris containing iron should not be overlooked. Gortner[12] in an analysis of the melanin pigments of hair showed that at least part of this hair pigment contained a rather high iron content. Retina has about three times the iron content of optic nerve.

Copper also takes an intimate part in cellular oxidations. That copper is necessary to the formation of hemoglobin has been shown by the studies of Schultze, Elvehjem, and Hart.[13] The polyphenol oxidase from potatoes has been demonstrated by Kubowitz[14] to be a copper-protein complex. Copper salts rapidly oxidize all three cytochrome components. Cohen and Elvehjem[15] find that copper when added to the diet will increase the cytochrome-a and indophenol oxidase concentration in animal cells. There seems to be a parallel between indophenol oxidase reaction and the copper content;

this parallel, however, does not hold for lens. The lens gives a negative or at most an extremely weak indophenol reaction. Its copper content, however, is approximately that of those tissues that give good positive reactions; for example, cornea. Since copper is so intimately associated with the intracellular oxidases, one may predict that the copper content would parallel the cellular content of a tissue. The lens, corneal stroma, sclera, conjunctiva, and vitreous humor are lower in copper than are the more cellular structures like corneal epithelium and retina. Nitzescu and Georgescu[16] report the copper content of aqueous humor as 14 to 18 micrograms per 100 c.c. These figures are of the same magnitude as our values for vitreous humor.

Manganese takes part in many physiologic processes. Edlbacher and Baur[17] report that arginase from yeast is inactive after dialysis and can be reactivated on addition of the manganese ion to the dialyzed system. However, there seem to be substances present that inhibit the manganese reaction, for manganese gives much greater activity when added to dialyzed samples than when added to undialyzed samples. The work of Theorell and Swedin[18] indicates that manganese with cytochrome-c has dihydroxy-maleic-acid oxidase activity. Süllman and Vos,[19] working with extracts of retina, have shown that manganese can be used interchangeably with magnesium in pyruvic-acid oxidation. Ochoa[20] has reported a similar phenomenon for brain. Rudra[21] finds that manganese acts like a coenzyme in the formation of ascorbic acid by the liver and he suggests that the insufficiency of manganese in the tissues of the guinea pig and of man may account for lack of ascorbic-acid synthesis. Since manganese has such a wide biologic distribution and is seemingly so essential to tissue metabolism, it is safe to postulate that manganese is of utmost importance to the ocular tissues. The corneal epithelium and the retina are much higher in manganese than are the other ocular tissues. This again fits in with the fact that corneal epithelium and the retina are highly active metabolic tissues.

Zinc is related to carbohydrate metabolism. Lohmann and Kossel[22] found zinc ions may either stimulate or retard yeast decarboxylase, depending on the concentration of the zinc ion. Hove, Elvehjem, and Hart[23] report a similar effect on alkaline phosphatase. A possible relation of zinc to the vitamin-B complex has been suggested by Eggleton,[24] for he finds the zinc content of the epidermal tissues in beriberi to be only half the normal content. Hove, Elvehjem, and Hart[25] find that rats on zinc-deficient diets have delayed intestinal adsorption. Foster and Waksman,[26] working with *Rhizopus nigricans,* find that zinc is indispensable for growth, and they conclude that zinc is probably closely related to carbohydrate metabolism. In insulin, zinc is a part of the molecule.

Zinc is coupled as the prosthetic group in carbonic anhydrase, which is an enzyme that facilitates the hydration of carbon dioxide and the dehydration of carbonic acid. Keilin[27] states that the zinc in the blood corpuscles is almost totally in combination with carbonic anhydrase. It is interesting to note that lens, which is not very active metabolically, has been reported by Bakker[28] to be extremely high in carbonic anhydrase. This may account for a large portion of the zinc in the lens.

The zinc content of lens is approximately of the same order as that of the retina and corneal epithelium. The iris has the highest zinc content of the ocular tissues; this may be related to some extent to the muscle content of the iris, for muscle tissue has a high carbohydrate metabolism. The corneal stroma, sclera, conjunctiva, and vitreous humor are relatively inactive metabolically, and it is not

surprising that the zinc content is low.

The presence of the trace metals affects the activity of cytochrome, cocarboxylase, and the dehydrogenase systems markedly. Since these enzyme systems are definitely connected with maintenance and growth of the cell, one can readily see the importance that the trace elements assume in the proper functioning of cellular metabolism. In cases of dietary deficiency that clinically are somewhat resistant to vitamin therapy, perhaps an adequate source of trace metals would be beneficial.

The lens with its structural advantage of being avascular would be extremely valuable in studying the relation of the trace elements to metabolism. At the same time these researches would uncover much of interest regarding the nature of lenticular metabolism.

Summary

The results of quantitative determinations of iron, copper, manganese, and zinc in the ocular tissues are recorded. The physiologic activity of these elements in relation to their mechanism in various biologic systems and of their effect on ocular metabolism with special reference to lens is briefly discussed.

950 East Fifty-ninth Street.

References

[1] Burdon-Cooper, J. A report on the spectroscopic examination of the mineral constituents of the human cataractous lens and that of healthy animal lenses. Trans. Ophth. Soc. United Kingdom, 1928, v. 48, pp. 340-346.

[2] Burdon-Cooper, J., and Lewis, S. J. The mineral constituents of normal and cataractous lenses. Concilium Ophthalmologicum, 1929, v. 13, pp. 185-189.

[3] Jackson, S. H. Determination of iron in biological material. Jour. Indust. Eng. Chem. Anal. Ed., 1938, v. 10, pp. 302-304.

[4] Elvehjem, C. A., and Lindow, C. W. The determination of copper in biological materials. Jour. Biol. Chem., 1929, v. 81, pp. 435-443.

[5] Wiese, A. C., and Johnson, B. C. A new method for the microdetermination of manganese in biological materials. Jour. Biol. Chem., 1939, v. 127, pp. 203-209.

[6] Skinner, J. T., and Peterson, W. H. The determination of manganese in animal materials. Jour. Biol. Chem., 1930, v. 88, pp. 347-351.

[7] Caughey, R. A., Holland, E. B., and Ritchie, W. S. Report on zinc. Jour. Assoc. Official Agri. Chem., 1938, v. 21, pp. 204-207.

[8] Zuckerkandl, F., and Messiner-Klebermass, L. Ueber die Rolle des Eisens bei der alkoholischen Gärung. Biochem. Zeit., 1933, v. 261, pp. 55-63.

[9] Zuckerkandl, F., Fleischmann, W., and Drucker, G. Ueber die Rolle des Eisens bei der glykolyse tierischer Gewebe. Biochem. Zeit., 1934, v. 271, pp. 435-438.

[10] Ustvedt, H. J. Die Rolle des Eisens bei der Glykolyse des Blutes und der Muskulatur. Biochem. Zeit., 1933, v. 265, pp. 154-156.

[11] Weekers, R. L'acid lactique du cristallin. Arch. d'Opht., 1937, v. 1, pp. 707-717.

[12] Gortner, R. A. On two different types of melanin. Proc. Soc. Exper. Biol. and Med., 1911-1912, v. 9, pp. 120-121.

[13] Schultze, M. O., Elvehjem, C. A., and Hart, E. B. Studies on the copper and iron content of tissues and organs in nutritional anemia. Jour. Biol. Chem., 1936, v. 116, pp. 93-106.

[14] Kubowitz, F. Ueber die chemische Zusammensetzung der Kartoffeloxydase. Biochem. Zeit., 1937, v. 292, pp. 221-229.

[15] Cohen, E., and Elvehjem, C. A. The relation of iron and copper to the cytochrome and oxidase content of animal tissues. Jour. Biol. Chem., 1934, v. 107, pp. 97-105.

[16] Nitzescu, I. I., and Georgescu, I. D. Ueber den Kupfergehalt des Augenwassers und seine Bestimmung. Klin. Woch., 1935, v. 14, p. 97.

[17] Edlbacher, S., and Baur, H. Weitere Mitteilung zur Kenntnis der Natur der Hefe- und Leberarginase. Zeit. f. physiol. Chem., 1938, v. 254, pp. 275-284.

[18] Theorell, H., and Swedin, B. Mangan als Aktivator der dioxymaleinsäure Oxydase. Naturwissenschaften, 1939, v. 27, pp. 95-96.

[19] Süllman, H., and Vos, T. A. Der glykolytische Kohlenhydratabau in Extrakten der Retina. Enzymologia, 1939, v. 6, pp. 246-257.

[20] Ochoa, S. Necessity of magnesium in the pyrurate oxidation system of brain. Nature, 1939, v. 144, p. 834.

[21] Rudra, M. N. Role of manganese in the biological synthesis of ascorbic acid. Nature, 1939, v. 144, p. 868.
[22] Lohmann, K., and Kossel, S. J. Ueber die Einwirkung des Zinks und anderer Metalle auf die Carboxylase. Naturwissenschaften, 1939, v. 27, pp. 595-596.
[3] Hove, E., Elvehjem, C. A., and Hart, E. B. The effect of zinc on alkaline phosphatases. Jour. Biol. Chem., 1940, v. 134, pp. 425-442.
[24] Eggleton, W. G. E. The zinc content of epidermal structures in beriberi. Biochem. J. 1939, v. 33, pp. 403-406.
[25] Hove, E., Elvehjem, C. A., and Hart, E. B. The physiology of zinc in the nutrition of the rat. Amer. Jour. Physiol., 1937, v. 119, pp. 768-775.
[26] Foster, J. W., and Waksman, S. A. The specific effect of zinc and other heavy metals on growth and fumaric acid production by Rhizopus. Jour. Bact., 1939, v. 37, pp. 599-617.
[27] Keilin, D., and Mann, T. Carbonic anhydrase. Nature, 1939, v. 144, pp. 442-443.
[28] Bakker, A. Ueber Kohlensäureanhydrase in normalen und kataraktösen Linsen. Arch. f. Ophth., 1939, v. 140, pp. 543-552.

THE DIAGNOSIS OF OCULAR SYPHILIS*

BRITTAIN FORD PAYNE, M.D.
New York

The diagnosis of syphilis is based on the clinical appearance of the lesions, the examination of secretions by dark-field, and various serologic tests. In the primary stage, it is important to perform repeated tests by dark-field illumination, since Wassermann findings are not entirely definite until the ninth or tenth week after inoculations. Stokes[1] states that only about 80 percent of the Wassermann tests are positive at the tenth week, which indicates that the disease might be diagnosed earlier if sufficient dark-field tests are made.

A complete physical examination is essential in the diagnosis of syphilis, and treatment should be planned according to physical findings. It is important to know the condition of the kidneys, lungs, and cardiovascular system before treatment is considered. A neurologic examination may show involvement of the central nervous system; concurrent tuberculosis might bar the use of iodides; arsenicals might be contraindicated in the presence of kidney disease. Moore[2] states that nine tenths of the "slip-shod" treatment of syphilitic patients occurs because the physician examines only the presenting lesion.

The importance of an early diagnosis of syphilis is manifest. It is possible to "cure" from 98 to 100 percent of the cases if treatment is started within 14 days after inoculation, but only approximately 80 percent can be "cured" if treatment is delayed until the Wassermann test is positive. This means that a few days' delay in treatment may affect seriously the final outcome.

The diagnosis of the chancre is a definite laboratory procedure. Differential characteristics described by various authors are of minor importance. The demonstration of the treponema with dark-field examinations, within the first 10 days after infection, is successful in from 90 to 95 percent of cases, whereas the Wassermann test is usually negative during this period. About 80 percent of the primary lesions may be diagnosed by dark-field tests through the fifth week. After this period, the organism disappears from the lesion and the Wassermann-positive rate increases; the test almost always becomes positive. The primary lesion should receive no local treatment

* From the Department of Pathology, New York Eye and Ear Infirmary, and New York University-Bellevue Medical School.

until at least three dark-field examinations are negative. A "local" Wassermann test may be of great value, for a positive reaction may be obtained several weeks before the blood becomes positive. A suspicious lesion requires repeated dark-field and serologic tests. A Wassermann test should be repeated weekly for the first month and every two weeks for an additional two months. Approximately 15 percent of the mixed infections will show syphilis. A therapeutic test or so-called "provocative" test is not advised in primary syphilis but is of considerable value in later manifestations of the disease.

Other diseases giving positive Wassermann reactions

Treatment should never be commenced until the identity of the organism is determined. A positive test usually indicates that the patient has syphilis, but in the absence of physical signs or history of the disease several examinations should be made. Yaws, relapsing fever, and leprosy are other diseases that give positive Wassermann findings. Most laboratories perform precipitation tests to verify their Wassermann reactions. It should be remembered that approximately 20 percent of the latent cases of syphilis will show negative Wassermann reactions. Moreover, it cannot be stressed too strongly that a negative test does not disprove the presence of syphilis.

Correct diagnosis of syphilis is so important to the patient that a careful clinical survey, with due consideration of the history and the progress of the lesions, should preface all laboratory procedures, however accurate or scientific. To stigmatize a patient as syphilitic on clinical evidence alone is as cruel as a laboratory director submitting a positive report on the reaction of one single test. The confusion that arises in the mind of the practitioner on receiving a report from the laboratory which fails to state definitely whether the case is *positive, doubtful,* or *negative* may cause needless treatment and considerable suffering on the part of the patient. Better laboratories usually ask for several specimens and numerous checks and rechecks are performed before a definite decision is made.

Early confirmation of the diagnosis of primary syphilitic lesions about the eyes is possible with the dark-field technique. The equipment is fairly simple, and once the diagnosis is made the chances of a definite cure are greatly enhanced by instituting vigorous treatment immediately. If further confirmation by serologic tests is required, the practitioner must wait for at least six or eight weeks for the results. The chances of positive cure are lessened in proportion to the time elapsing before treatment is started. The technique for dark-field examinations may be reviewed in any standard textbook dealing with laboratory examinations for syphilis.

Uniform standard tests

The approved serologic tests for the detection of syphilis as outlined by the "Standardization Committee"[3] consist of the following:

Complement fixation techniques: Kolmer (modification of the Wassermann tests); Eagle (modification of the Wassermann test).

Flocculation techniques (standard): Kahn standard; Kline diagnostic; Eagle microflocculation; Hinton.

Screen flocculation (supersensitive, for special purposes): Kahn presumptive; Kline exclusion.

No attempt will be made to describe the techniques of the aforementioned tests, but the importance of limiting the vast array of laboratory procedures to a uniform and universal scale is well recognized by syphilologists and ophthalmolo-

gists. The primary object of all complement of fixation and flocculation tests is to detect the presence of the same substance, so-called reagin, which is probably an antibody to the Spirochaeta pallida. An efficient technician may select one of the tests under each group and arrive at a diagnosis. A poor technician will fail if dozens of tests are performed. It has been suggested that the generic term "Serologic test for syphilis," or abbreviated "STS," be used and embrace the following five types of tests in current use:

Screen flocculation: Any recognized technique that gives false positives in a certain percentage of normal individuals.

Flocculation: A standard flocculation technique in which an alcoholic-tissue extract is used as an antigen.

Complement fixation: Any standard Wassermann technique using alcoholic-tissue extract as antigen.

Spirochetal complement fixation: Complement fixation with spirochetal suspension as antigen.

Verification: Kahn test or modifications thereof.

The Standardization Committee emphasizes that all of the aforenamed tests should be positive, but warns that if the serologic result does not correspond to the history and the physical findings a second specimen of blood should be examined. A doubtful reaction is noted if there is a discrepancy between some of the tests employed. It should be remembered that in doubtful and negative results the patient may have been treated or the specimen may have been presented before there was sufficient general reaction.

In the event of spinal-fluid examination, at least four essential tests should be performed: a quantitative Wassermann test, a globulin estimation, a cell count, and a colloidal test. Most laboratories perform these tests with great accuracy.

Ocular syphilis

Ocular syphilis may be congenital or acquired. According to Parran,[4] syphilis affects the eye in at least one third of all congenital cases, unless properly treated. Lemoine[5] states that the incidence of ocular lesions is 40 percent or more. The disease may wait for years to assert itself or it may be evident at birth. The most common manifestation is interstitial keratitis, which is usually seen from the fourth to the twentieth year, but which may occur in adult life.

Interstitial keratitis

Interstitial keratitis,[6] which may develop in the center or periphery of the cornea, usually affects both eyes in spite of treatment. If it begins in the center of the cornea, small maculas tend to become confluent and cloudy. The lesions are present in the stroma and some may be quite deep. As the disease progresses, the cornea becomes uniformly cloudy. Deep blood vessels enter the stroma from the limbus in tufts, giving the appearance of a brush. When the disease starts in the periphery, deep blood vessels enter the stroma with an advancing area of haziness. The cornea becomes lusterless and the maculas progress centrally. The disease follows a chronic course and usually reaches its height at the end of one or two months. The entire uvea is affected, and precipitates are seen on the cornea and endothelium. These signs suggest the use of mydriatics and hot applications during treatment.

The general appearance of the patient aids in the diagnosis of interstitial keratitis.[7] The presence of "Hutchinson's triad," which consists of interstitial keratitis, notched teeth, and deafness, is indicative of congenital syphilis. A peculiar formation of the face and cranium with

a prominent forehead and "saddle nose," the presence of ozena with disease of the lacrimal sac and notched or pegged incisor teeth are signs of syphilis. Old rhagades or scars about the mouth, enlarged lymph glands, tophi of the long bones and, occasionally, an involvement of the knee joint are all indications of the disease.

Congenital syphilis may also affect the eyelids, conjunctiva, orbit, and optic nerve. The entire uvea, the sclera, and the retina are usually involved when the cornea becomes inflamed.

In the differential diagnosis of interstitial keratitis, it is necessary to eliminate deep sclerosing keratitis, tuberculosis, leprosy, trachoma, keratitis disciformis, glaucoma, and the effect of chemicals. Most of these diseases may be eliminated by the Wassermann reaction.

Acquired syphilis of the eye

Acquired ocular syphilis may manifest itself as a chancre of the eyelid, eyebrow, or conjunctiva. It is most frequently seen in the region of the inner canthus. The lesion presents the same pathologic picture in this region that it does about the genitalia. Induration, ulceration, and lymphatic involvement are evident. The dark-field examination is usually positive.

Secondary lesions may appear as annular or circinate manifestations resembling various ringworm infections. A gumma may develop as a small induration on the eyelid or involve the greater part of the orbit, causing proptosis and signs of a retrobulbar tumor. The most common involvement of the orbit is a gumma, and the patient may or may not have considerable pain. The lesion is especially amenable to treatment.

Nerve involvement

Involvement of the nerves of the eye often occurs in neurosyphilis. This is demonstrated by the Argyll Robertson pupil. Irregularities in the size and shape of the pupils with variations in their reactions to light and accommodation should suggest syphilis. Complete and partial ophthalmoplegia may occur, but an individual nerve is seldom affected. However, two patients in whom one sixth nerve alone was affected in each were observed recently. Both patients had received vigorous intravenous therapy, which may have caused an involvement of the nerve. It is commonly known that the sixth nerve is well exposed to the blood stream, and it is possible that arsenicals affected it in both cases. In the routine examination of the patient, it is important to test corneal sensitivity, because the fifth nerve may be involved.

Syphilitic involvement of the optic nerve is usually observed late in the disease. It manifests itself as a chronic degenerative change due to ischemia and invasion of the spirochetes into the nerve bundles. The nerve is most often affected in neurosyphilis, but gummatous involvement has also been reported. A case of gummatous involvement of the optic nerve was observed at the New York Eye and Ear Infirmary in 1905, and the eye was removed for suspected tumor. The ophthalmoscopic appearance of the disc in syphilitic atrophy is usually grayish in appearance but may be almost white. The caliber of the retinal arteries is diminished and areas of choroiditis may be seen with the ophthalmoscope.

The cornea is seldom involved in primary or secondary syphilis, but may become inflamed by extension of a primary lesion from the conjunctiva or by deposits of precipitates on the endothelium from iridocyclitis. The cornea is frequently involved in congenital syphilis.

Syphilitic iritis

Syphilitic iritis *is usually acquired* and

involves the iris, ciliary body, and choroid. Although it occurs most often in the secondary stage, it may be congenital. Syphilitic iritis, which is characterized by some pain and photophobia with diminution of vision, accompanies such manifestations as skin eruptions and involvements of the mucous membranes. The lesions in the iris are classed as papules or nodules that may be the size of a pinhead and present only at the periphery or near the pupillary margin. These tend to heal and disintegrate as the disease progresses. Slitlamp examination reveals cells in the anterior chamber, adhesions to the anterior capsule of the lens, and deposits on the endothelium. In some cases, there is no localized evidence of the disease, and one must rely on the slitlamp, mucocutaneous lesions, and the Wassermann reaction for a diagnosis. A gumma, which is quite painful, may develop in the iris or ciliary body, and cause increased intraocular pressure and inflammation of the choroid. Syphilitic iridocyclitis usually responds more rapidly to treatment than do other ocular manifestations of the disease.

Scleritis caused by the Treponema pallidum is usually confused with a tuberculous or arthritic condition.

Involvement of the retina and optic nerve offers a different problem. If the blood vessels supplying the retina are diseased and the nerve shows evidence of atrophy, the treatment should be modified accordingly. The best check on the ophthalmoscopic appearance of the fundus is the visual-field test. Visual fields should be checked at least a week or so after each injection of tryparsamide. Until it is definitely proved that arsenic does not affect the optic nerve in advanced syphilis, it is wiser to be cautious with treatment. Acute optic neuritis caused by syphilis is rare. Retrobulbar neuritis and involvement of the chiasm may occur in some instances. In these cases, visual-field tests are most important.

Treatment of ocular syphilis

Ocular syphilis is a local manifestation of a general disease and should be treated accordingly. It is true that there are certain local adjuvants, but the eventual result of treatment depends upon the administration of arsenic and heavy metals. Mercury, in some form, has been a remedy since the disease was first recognized and, aside from late developments in the arsenicals and bismuth, nothing of importance has been introduced until recently. The value of fever therapy has been recognized for many years.

The ophthalmologist should play the role of an umpire in the treatment of syphilis. He should not attempt to treat general manifestations but confine his attention to the eye. He should use hot applications, mydriatics, and such ointments as may be necessary. He should make visual-field tests and advise the physician or syphilologist on the progress of the eye lesion.

896 Madison Avenue.

References

[1] Stokes, J. H. Modern clinical syphilology. Philadelphia, W. B. Saunders Co., 1936, p. 596.
[2] Moore, J. L., and collaborators. The management of syphilis in general practice. Reprint #13, Ven. Dis. Informs., 1929, v. 10, Feb. 20, no. 2.
[3] Moore, J., and Eagle, H. J. Confusing multiplicity of serologic tests for syphilis. Jour. Amer. Med. Assoc., 1941, v. 117, July 26, no. 4, p. 243.
[4] Parran, T. Shadow on the land. Reynal and Hitchcock, 1937, p. 300.
[5] Lemoine, A. N. Ocular manifestations of congenital syphilis and treatment by induced hyperpyrexia. Trans. Amer. Ophth. Soc., 1934, v. 32, p. 522.
[6] Fuchs, E. Textbook of ophthalmology. New York, J. B. Lippincott Co., 1917, p. 288.
[7] Cole, H. N. Congenital and prenatal syphilis. Jour. Amer. Med. Assoc., 1938, v. 109, no. 8, p. 580.

NEAR HORIZONTAL PHORIA AND DUCTION TESTS*

A CLASSIFICATION OF FINDINGS

SAMUEL V. ABRAHAM, M.D.
Los Angeles, California

In this study the phorias and ductions were examined at distance and at near vision in 4,000 patients. The results of the observations made agree with those of investigators who claim no definite correlation between the error of refraction and the phoria present (Zentmayer,[1] Mann[2]). Patients seem to react differently to the same or different heterophoric conditions. After careful refraction patients with defective vision, as a group, show no marked differences in the phoria findings at distance and at near than does a group without ocular complaints (Bielschowsky[3, 4]).

To be of any considerable value for the elucidation of ocular problems, the muscle findings should be consistent in amount and in relation to the general discomfort. Few, if any, workers claim this virtue for the phoria findings. They vary too greatly from day to day, and even from moment to moment in an individual (Bielschowsky[3]), to be of use in any basic study of the problem involved. The daily activity of fusion from childhood cannot but have a significant effect on the results of tests for heterophorias. The considerable divergence of opinion regarding therapy in heterophorias is largely due to dependence on data involving these very variable phoria findings.

In the cases forming the basis of this study the histories were given considerable attention. In the group of subjects with normal vision only those without ocular complaints were included who used their eyes sufficiently in their daily activities to assume that an average demand was being made upon the extraocular-muscle mechanism. (They held some clerical job or read 2 to 4 hours daily.) The duction findings for the two groups —that is, those with and those without ocular complaints—were examined and were shown to present certain differences worthy of further attention.

While differences in the duction findings at distance fixation were apparent in the two groups, these were relatively slight and irregular when compared with the findings at near fixation. Because of the greater ease in the demonstration of consistent differences in the duction findings for the two groups at near fixation, it was decided to concentrate on a study of these near ductions. Actually any information supplied by the distance duction tests is not sacrificed. The near duction tests not only supply this information but they do so more clearly and more consistently. Furthermore, it seems more logical to study in greater detail the convergence function at the point at which it is given the major use.

The literature was searched for data concerning normal near duction findings. Clausen[5] gives Alfred Graefe's figures for average duction findings with fixation at 13 inches as abduction, 5 to 10 prism degrees; adduction, 30 prism degrees or more. Duane[6] in a monograph on the "Norms of convergence" gives no prism duction findings for near fixation. He used prisms for distance only and relied on the "approach-the-nose" method to obtain the amount of convergence present. Berens, Losey, and Hardy[7] give as normal ductions for near (25 cm.) 16.47 prism diopters for abduction in 218 picked men, and 19 prism diopters for ab-

*Presented before the Los Angeles Ophthalmological Society in 1939.

duction in 300 other consecutive cases from office practice. In these two series of cases the adduction was 38.02 prism diopters and 41 prism diopters, respectively. These tests were made with prism bar, not with rotary prism. Sheard[8] without data gives the normal convergence reserve (prism base-out reading) at 13 inches as 30 prism diopters. He considers the "fusional convergence" in force as indicated by the "exophoria" at near, and prefers a 3:1 relationship for prism base out to exophoria. Dobson[9] without data also gives 30 prism diopters base out as the normal reading for 13 inches. She gives the normal base-in reading at 13 inches as 18 prism diopters. Weymouth, Brust, and Gobar,[10] using rotary prisms, found that the average "prism base out" overcome in 107 cases (with an interpupillary distance of 64.45 mm.) upon fixation at 13 inches, was 19.8 prism diopters. In 87 cases they found the "base in" reading (negative reserve convergence) to be 17 prism diopters. Maxwell[11] prefers a 1:1 relationship at 13 inches. He considers, therefore, 18 prism diopters as the normal base-out reading (positive reserve convergence) for this near distance. Judging from the paucity of references and the considerable differences in the "normal" findings, one is led to conclude that very little attention is given the duction tests at near. Dependable data concerning the ductions at near are rarely presented.

Reference to the tables presented in this study suggest that at the 13-inch fixation point the finding of a considerably greater *base-out* reading (positive reserve convergence or adduction) than *base-in* reading (negative reserve convergence or abduction) is rare. Sound physiologic principle requires that for comfort a function should maintain reserve energy at least equal in amount to that being normally expended in the performance of its function. Such a finding in regards to the convergence function is aimed at but is not too frequently found. This may be due in part to the youthfulness of the convergence function from an evolutionary point of view. A conservative view, based on the results of several thousand examinations at near, leads one to expect a base-in reading slightly larger than the base-out reading (1+ :1).

A study of the ductions at near is, on analysis, a study of the convergence function. This method of study is considered superior to the approach-the-nose method as its findings are more easily repeated, and can more consistently be correlated to other dependable data. Dobson,[9] too, agrees that this approach-the-nose method is "loaded with inaccuracies." The approach-the-nose method of studying the convergence function is favored by Banister,[12] as being more reliable than the prism-duction method. Maxwell,[13] however, takes the opposite view and says the prism-duction method is superior. He considers the fact important that many patients who have normal near points for convergence show subnormal convergence reserve when tested by the prism-duction method. It seems more logical to expect that the effort *initially* put forth to effect binocular fixation at an ever-changing point will usually be greater than the effort to *maintain* this function. The positive reserve convergence reflects the ability to maintain this function.

A similar superiority of the duction method at near over the phoria tests is also claimed. Many subjects who have normal near points of convergence and "normal" phoria findings at 13 inches continue to have ocular complaints that are explained by the finding of little or no reserve convergence for use at the 13-inch distance, as evidenced by the

duction method. Irregularities in findings in testing such a physiologic function cannot be eliminated. However, a certain amount of dependence on the regularity of the findings must be present if any uniformity of opinion is to be reached regarding either the cause of or the therapy for disturbances of the extra-ocular muscles.

Since findings in muscle tests may vary considerably, it is necessary here to describe in detail the method of testing as used by the author, so that variations due to the examiner may be eliminated in so far as possible. The tests were made on an average of three different times per patient, never less than twice. These patients' histories were negative for previous eye-muscle exercise.

Muscle tests

The patient was seated with eyes fixed upon a 1-cm. round light situated at 6 meters. He looked through an adjusted phoro-optometer containing his distance correction (which was usually his cycloplegic refraction or within 0.50D. thereof). The Maddox-rod test was used for determining the horizontal and vertical phorias; these were measured and corrected by means of rotary prisms. The Maddox rod was then removed, and the ductions tests were made; first the vertical ductions, as described by the author.[14] Any vertical phoria found was corrected by the proper prism, if necessary. The horizontal ductions were then taken; first the base-out readings and then the base-in readings. The amount of prism used barely to create diplopia was recorded for all ductions.

The tests were repeated at near (33 cm.) fixation. Here the necessary addition to the distance prescription was made for the cycloplegia (if present) or for the presbyopia. The Maddox rod and a small light were used in some of the early cases. Most of the tests were made by the use of a small (1.2 mm.) black dot or letter on a white card. A vertical prism before either eye was used to create diplopia, and the horizontal separation was measured by a prism before the other eye. This gave the amount of exophoria or esophoria present. The vertical ductions were then made with the horizontal prism just used left in place. Any vertical phoria found was corrected by prisms if necessary to avoid diplopia. The patient closed his eyes for a moment at this point, and the horizontal prism was reduced to zero. Then with the eyes again open, the prism base-out reading was first taken. This test was made first and in this manner to obtain the largest base-out reading possible under the circumstances. Taking base-out readings after the base-in would more frequently lead to exceptionally low base-out readings, even minus readings. The opposite was not often true; that is, taking base-in readings after base-out readings was found not materially to affect the base-in readings. After obtaining the amount of base-out prism necessary to induce diplopia, the prism was reduced to zero or less to permit recovery from the diplopia. At this point the patient was permitted to rest the eyes for a moment before making the base-in reading.

Refractions were done under homatropine or atropine cycloplegia. No case has been used in the series of cases here given if the error of refraction was greater than ±4.00 D.; if the visual acuity of either eye was less than 0.8 (20/25); if the astigmatism was over 1.50 D.; if the difference in the refraction in the two eyes was 2.00 D. or more in either of the principal meridians; if any organic disease of the fundi, media, or muscles was present; or if strabismus, constant or intermittent, was present. Single binocular vision and fixation with

good depth perception were present. In brief, the cases are of the average type, frequently seen in practice.

The blur points and recovery points have not been added to the data here presented as they add no essential information, although a consideration of these points together with the duction readings may sometimes prove helpful. Actually, the base-out recovery point may frequently give very low readings even though the base-out break point is not found unusually low. Such a reading may be an additional indicator of a low convergence reserve or may be due to a decrease in the attention factor. However, while it would appear that the recovery point is important in reducing the number of cases of convergence weakness missed, actually the base-out break reading on repetition of the tests at the same sitting or at some future sitting will usually give the true picture of the convergence reserve.

It has been aimed to keep the tests short and simple, as only in this way can we hope to increase the interests of the practitioner, which in turn may lead to a better understanding of the problems concerned. That the simplification has seemed to clarify the situation is shown by the data herewith presented. An examination of the data as they accumulated showed that the cases covered by this presentation could be divided into three groups; one, the normals; two, the subnormals; and three, the abnormals.

In table 1 are presented the horizontal phorias and ductions as found in 300 cases divided into these three groups. The first 100 are considered "normals"—those without ocular complaints after refraction, despite average demands upon the visual apparatus. The second 100 are considered subnormals in which the outstanding symptom is one of tiring, both ocular and general. The third 100 are considered the abnormals. Analysis of the symptoms and the findings in this group requires greater care than is usually necessary in dealing with the cases in the other groups. However, one may say that the chief symptom in this group is one of increased irritability or lowered threshold of tolerance. This increased irritability or lowered tolerance was evident not only in the eyes but in the patients' reactions to daily problems.

It will be noted that the individual near phorias varied considerably. In the "normal" group the phorias varied from zero to 11 prism diopters of exophoria. In the subnormal groups the tendency was towards slightly higher readings, although individual variations ran from zero to 22 prism diopters. In the abnormal group the phoria findings were even more varied. Many patients who showed little or no phoria finding for distance, showed an "esophoria" at the near distance (13 inches). In this group the findings varied from 8 prism diopters of exophoria to 18 prism diopters of esophoria. The phoria findings showed little relation to the type of refraction, except that in cases of myopia, especially in adolescents, esophoria was more frequent.

A study of table 1 reveals that the phoria found may be the same in individuals in all three groups, although the tendency for the subnormals (group II) is towards showing an increased exophoria while that for the abnormals (group III) is towards showing a decreased exophoria. The average phoria found in group I, the "normals," was 6.22 prism diopters of exophoria; in group II, 8.55 prism diopters of exophoria; and in group III, 1.23 prism diopters of esophoria.

The base-in reading in the normals and the subnormals did not differ materially, varying in the first group from

TABLE 1

RESULTS OF HORIZONTAL MUSCLE TESTS AT 13 INCHES IN 300 TYPICAL CASES*

Case No.	Phoria	Abd.	Add.	Case No.	Phoria	Abd.	Add.	Case No.	Phoria	Abd.	Add.	Case No.	Phoria	Abd.	Add.	Case No.	Phoria	Abd.	Add.
Normals																			
1	6	20	19	21	5	22	19	41	0	23	20	61	6	18	17	81	8	22	16
2	4	26	22	22	2	17	24	42	6	22	22	62	6	22	20	82	4	20	21
3	0	18	18	23	4	18	19	43	8	22	22	63	9	21	18	83	2	22	20
4	8	24	20	24	8	24	20	44	6	21	19	64	8	19	21	84	10	22	21
5	6	18	21	25	4	18	18	45	6	20	21	65	2	18	16	85	6	21	23
6	10	20	16	26	3	17	23	46	4	20	18	66	3	17	19	86	4	19	17
7	6	22	20	27	3	18	16	47	8	22	24	67	6	18	22	87	8	21	20
8	4	29	16	28	8	20	18	48	6	22	16	68	8	18	16	88	6	20	21
9	10	22	22	29	1	18	20	49	6	22	26	69	6	19	21	89	8	20	20
10	13	26	18	30	8	24	18	50	3	20	18	70	6	21	18	90	6	18	17
11	5	22	16	31	7	24	22	51	2	20	18	71	8	20	19	91	2	22	17
12	10	20	20	32	9	25	16	52	4	22	20	72	5	24	22	92	13	14	22
13	7	20	16	33	4	21	16	53	10	24	24	73	4	22	20	93	8	24	22
14	4	23	20	34	6	22	17	54	9	22	21	74	10	19	19	94	11	28	20
15	11	26	20	35	8	28	22	55	8	18	20	75	9	27	21	95	10	26	24
16	5	18	21	36	8	22	18	56	6	27	18	76	8	22	23	96	8	24	20
17	8	26	16	37	6	21	19	57	8	21	17	77	7	22	24	97	8	17	18
18	4	18	24	38	5	18	19	58	3	17	16	78	6	20	18	98	7	25	22
19	6	20	19	39	5	15	24	59	10	21	19	79	8	27	25	99	4	24	18
20	0	22	19	40	10	20	17	60	10	17	26	80	5	21	20	100	4	22	20
Subnormals																			
101	7	16	9	121	5	19	8	141	16	24	10	161	10	20	31	181	2	23	13
102	8	22	8	122	3	19	14	142	2	7	22	162	20	31	10	182	2	21	10
103	10	17	0	123	3	18	10	143	9	16	6	163	10	20	6	183	2	19	0
104	12	24	9	124	11	19	7	144	18	32	13	164	12	24	8	184	4	20	8
105	8.5	25	6.5	125	12	20	10	145	8	18	6	165	15	24	6	185	12	24	8
106	6	22	10	126	13	24	6	146	7	18	8	166	12	24	8	186	16	27	8
107	8	18	6	127	5	18	14	147	2	20	12	167	15	24	6	187	4	16	0
108	4	21	13	128	0	16	13	148	0	18	12	168	12	18	6	188	11	19	13
109	2	17	3	129	2	18	10	149	8	20	8	169	3	17	10	189	1	26	14
110	2	16	12	130	15	20	2	150	4	18	13	170	7	20	4	190	16	26	0
111	8	20	6	131	6	18	8	151	2	20	14	171	11	22	5	191	1	24	12
112	18	32	4	132	10	18	4	152	3	18	6	172	10	25	11	192	18	24	13
113	15	20	4	133	0	18	8	153	8	22	14	173	12	26	0	193	7	23	19
114	17	23	3	134	21	27	0	154	22	24	0	174	9	27	14	194	7	26	14
115	2	20	12	135	10	19	6	155	10	18	8	175	8	21	12	195	4	20	11
116	14	20	13	136	9	24	12	156	7	18	8	176	7	19	4	196	4	17	8
117	12	26	0	137	20	29	0	157	6	17	12	177	4	23	13	197	3	22	10
118	10	22	10	138	145	30	4	158	12	20	2	178	16	27	2	198	14	21	10
119	6	22	8	139	6	18	6	159	10	21	9	179	6	18	10	199	3	19	7
120	13	30	11	140	7	22	8	160	8	18	8	180	6	20	10	200	6	24	10
Abnormals																			
201	1	14	21	221	7E	25	20	241	4E	18	10	261	6E	8	18	281	2E	18	14
202	1.5	9	18	222	9E	13	23	242	2E	3	16	262	10E	10	20	282	0	14	20
203	1E	6	7	223	6E	25	20	243	1E	14	17	263	6	14	14	283	2	12	21
204	4E	8	22	224	3E	10	22	244	3	8	6	264	1E	14	31	284	10E	4	28
205	2	11	8	225	4E	16	14	245	8	17	48	265	0	10	12	285	25	8	24
206	10E	6	24	226	5	14	6	246	4	15	10	266	0	16	15	286	6	14	22
207	6E	4	20	227	4	12	5	247	1.5	9	9	267	2E	9	24	287	8	12	20
208	6E	14	22	228	0	13	12	248	1	13	21	268	18E	12	39	288	8E	6	16
209	0	14	19	229	4E	12	18	249	1E	14	22	269	3E	14	20	289	4E	14	28
210	5	15	24	230	3	9	12	250	0	14	12	270	2E	22	16	290	0	12	20
211	0.5	12	18	231	8E	16	30	251	1.5	15	8	271	0	10	14	291	1	16	18
212	2E	12	20	232	4	6	24	252	2E	18	14	272	2	11	3	292	4E	15	24
213	0	15	19	233	8	16	8	253	6E	14	20	273	8E	12	14	293	6E	11	26
214	0	14	19	234	6	2	16	254	2.5	14	17	274	0.5E	17	16	294	1	12	22
215	10E	6	24	235	0	12	14	255	5	9	6	275	0	14	12	295	2	12	20
216	1E	6	22	236	10E	27	26	256	7E	14	27	276	1E	11	14	296	2E	17	17
217	2	13	23	237	6	11	14	257	6E	8	18	277	3E	14	20	297	0	12	16
218	10E	8	27	238	3	9	10	258	3	15	10	278	1E	6	22	298	3	14	12
219	4E	9	11	239	1E	12	20	259	0	6	6	279	6E	15	20	299	2E	14	20
220	1E	14	22	240	0	10	0	260	1	10	16	280	2E	22	16	300	1E	15	22

* Phoria is given in prism diopters. E, following a number, means esophoria. Otherwise exophoria is meant. Abd. = abduction, break point with prism base in (negative reserve convergence). Add. = adduction, break point with prism base out (positive reserve convergence). Notations same in subsequent tables.

15 to 29, averaging 21.24 prism diopters, and varying in the second group from 16 to 32, averaging 21.43 prism diopters. In the third group, the abnormals, the base-in readings differed considerably from the normals and the subnormals. Here the base-in readings tended to be low. They varied from 4 prism diopters to

27, exceeding 17 in but few cases. The average was 12.55 prism diopters.

A study of the base-in readings in the normal and subnormal groups shows that both groups have the ability to relax all the convergence used to bring the eyes from parallelism to near fixation (and even a little more than this). The abnormals differ definitely in this respect, usually not possessing this ability. The tendency in the abnormal group to fail to give up the convergence in use at the moment suggests an increased convergence impulse. This may logically explain the aforenoted tendency towards less than normal exophoria and even an esophoria.

Before one can intelligently discuss the variations in base-in readings and their possible relation to the state of the convergence function, it is desirable to know what the expected reading should be. This seems to vary somewhat with the patient and with the interpupillary distance (Pascal[15]). It would be only natural to expect some relation between the amount of convergence surrendered (by use of base-in prism) and the amount of convergence in use.

Table 2 shows that not only are the base-in readings related to the interpupillary distance, but that the amount of negative convergence agrees closely with the amount of convergence computed (see Pascal) as needed to bring the eyes from parallelism to fixation at the near point concerned (here 33 cm.). Groups I and II show similar base-in readings and are reported together in table 2. Most if not all of the cases in group III are considered to be examples of overactive convergence, because the base-in readings in this group are usually considerably less than the expected amount. In these cases, the base-out readings are not considered reliable as indicators of the usual convergence reserve, masked as the true findings are by a temporarily overactive convergence. A considerable number of these cases have been shown closely to resemble the cases in group II when tested under cycloplegia (see table 3). In fact, the use of atropine to obtain relief in trouble-

TABLE 2

SHOWING RELATION OF PRISM BASE-IN READING AT 13 INCHES (ABD.) TO AMOUNT OF CONVERGENCE IN USE BASED ON INTERPUPILLARY DISTANCE (COMPUTED CONVERGENCE) IN 670 CASES

	P.D.	No. of Cases	Average Age	Phoria	Abd.	Computed Conv.	for P.D.
Normals and Subnormals Groups I & II	Under 64	270	32.4	6.5	20.9	19.2	64
	64 and over	302	35.3	7.8	23.2	21.0	70
	60	30	26.6	5.3	20.1	18.0	60
	62	108	31.4	6.5	20.8	18.6	62
	64	132	34.5	6.7	21.3	19.2	64
	66	110	32.0	6.4	22.7	19.8	66
	68	148	37.5	9.0	23.6	20.4	68
	68 and over	44	36.5	7.7	22.8	21.0	70
Abnormals Group III	under 64	48	34.5	1 E	12.3	19.2	64
	64 and over	50	35.1	0.16 E	11.1	21.0	70
	60	3	16.0	8 E	16.5	18.0	60
	62	21	34.4	0.3 E	13.1	18.6	62
	64	24	37.0	1.5 E	12.0	19.2	64
	66	23	33.0	0	13.1	19.8	66
	68	13	38.0	0.3	11.7	20.4	68
	68 and over	14	36.0	0.9	9.6	21.0	70
Aver.	65.2	670		6.07	20.6	19.6	65.2

some heterophoric cases is known (Brown,[16] Prentice[17]). Unfortunately, the conditions are not permanently changed by cycloplegia, and the conditions as existing before cycloplegia tend to recur when this is stopped. Sedation, too, will sometimes tend to decrease the over-activity of the convergence.

The subject of the vertical phoria is not included in this paper. However, it may be noted here that most cases in which vertical phoria was present were those belonging to the third group—the abnormals. When the excess or spasm of convergence disappeared, as under cycloplegia, or sedation, or other therapy, the vertical phoria frequently disappeared. It is possible that the vertical phoria found may have been due in many cases to an overflow of the impulses along the 3d nerve, so that some of the impulses to the internal recti muscles reach the vertical recti muscles, giving the impression of a vertical phoria.

Table 3 shows a fair number of cases of the abnormal group-III type, in which the findings under cycloplegia suggest group II. It may be noted that the first 12 cases shown have an esophoria or no phoria for near distance without cycloplegia and an exophoria when tested under cycloplegia. It is particularly worthy of note that the change of an esophoria to an exophoria under cycloplegia (first 8 cases of table 3) is also accompanied by an increase in the base-in readings. The average phoria at near in these 50 typical cases is 4.8 prism diopters without cycloplegia, 8.9 during cycloplegia. The average base-in reading without cy-

TABLE 3

HORIZONTAL MUSCLE FINDINGS AT 33 CM. BEFORE OR AFTER CYCLOPLEGIA COMPARED WITH FINDINGS DURING CYCLOPLEGIA. (50 CASES CHOSEN AT RANDOM.) TESTS MADE WITH PLUS ADDITION TO THE DISTANCE CORRECTION FOR ANY LACK OF ACCOMMODATION BECAUSE OF THE CYCLOPLEGIA OR PRESBYOPIA IF PRESENT

Case No.	Without Cycloplegia			Under Cycloplegia			Case No.	Without Cycloplegia			Under Cycloplegia		
	Phoria	Abd.	Add.	Phoria	Abd.	Add.		Phoria	Abd.	Add.	Phoria	Abd.	Add.
1	6E	25	20	6	27	17	26	7	20	9	9	20	9
2	7E	25	20	7	27	17	27	5.5	18	21	4E	20	20
3	9E	13	23	4	18	12	28	11	20	5	9	24	5
4	3E	10	22	7	21	13	29	13	21	14	14	22	0
5	4E	16	14	4	23	8	30	4	29	16	0	28	24
6	3E	10	22	7	21	13	31	8	22	8	2	23	8
7	4E	16	14	4	23	8	32	14	26	8	4E	22	16
8	4E	12	18	6	16	27	33	9	22	6	17	34	4
9	0	23	17	7	27	17	34	19	29	0	19	29	0
10	0	18	18	5	22	19	35	13	21	10	12	20	6
11	0	23	17	6	27	17	36	12	22	10	19	26	4
12	0	23	15	7	26	18	37	3	18	6	7	18	5
13	19	29	0	15	23	2	38	6	30	6	10	29	0
14	7	16	8	9	18	12	39	16	20	12	17	21	12
15	8	26	16	11	26	20	40	13	26	18	15	30	20
16	11	25	6	13	29	0	41	5	22	16	14	24	3
17	14	20	5	9	24	5	42	8	22	8	17	24	13
18	8	26	16	11	26	20	43	6	22	6	15	34	4
19	9	24	5	9	25	5	44	4	16	16	7	23	6
20	11	26	20	11	20	20	45	27	30	14	27	32	4
21	9	18	12	9	18	12	46	6	26	4	14	32	7
22	6	30	8	13	29	0	47	25	31	11	25	30	6
23	8	20	4	8	19	4	48	8	25	13	6	25	7
24	9	24	5	9	25	3	49	9	20	10	3	19	14
25	8	25	13	6	25	7	50	11	22	9	12	24	2

coplegia is 19.9 and 24.5 prism diopters during cycloplegia. The average base-out reading without cycloplegia is 12 prism diopters, and 10.4 during cycloplegia. A general tendency towards increased exophoria, increased base-in readings, and decreased base-out readings under cycloplegia may be noted.

The idea of a convergence spasm superimposed on or present together with a convergence weakness is, according to Bielschowsky,[18] "by no means unusual—a peculiarity seen especially in neurasthenia, an important characteristic of which is the combination of increased irritability and abnormal exhaustibility."

In group II the patient may be said to relax to his condition, reflecting his asthenic characteristics, while in group III, the patient may be said to be making a greater effort to overcome the basic condition. The apparent overactivity of the convergence function in group-III cases reflects an increased effort. Whether this means a spasm of convergence or a true excess of convergence or both is not always clear. In 1,500 consecutive eye examinations there were 121 cases in which the findings were characteristically irregular as noted above for group III. The base-out readings (table 1) in the normals differed considerably from those in the subnormals. In the normal group the base-out reading was usually 16 prism diopters or more, varying from 16 to 26, and averaging 19.63 prism diopters. In the subnormal group the base-out reading was below 15 prism diopters, varying from zero (or less) to 14 prism diopters, and averaging 8.08 prism diopters. In the abnormal group the readings varied considerably.

The abnormal group showed base-out readings at times resembling the normals and at times the subnormals. These base-out readings, which represent the reserve convergence under the test conditions, at first glance suggest a lack of dependability in these readings. However, this group of subnormals when examined in the light of all three findings—the phorias, and the base-in readings, and the base-out readings—do not differ materially from group II, the subnormals. It may be noted that when the base-in readings are low, showing incomplete relaxation of the convergence in use, the base-out readings may show "normal" or even higher results. One would expect such a result if the incomplete relaxation of the convergence is due to an overstimulated convergence. The base-out readings in this group (III) varied from zero to 39, averaging 18.49 prism diopters. In table 3 a tendency towards decreased base-out readings during cycloplegia may be noted, although some cases show no changes and a few actually show an increased tendency to "spasm" of convergence while under cycloplegia. Since all the persons concerned in this study could be shown to have normal motility, the problem could not be said to concern intrinsic muscle weakness. Since the same stimuli were used in all cases, the cause of the variations could not be looked for here. Without going into a detailed discussion of the relationship between convergence on one hand, and fusion, accommodation, and psychic factors, such as nearness of object and attention, on the other, it seems logical to consider a cerebration process, such as fusion, responsible for the lack of proper stimuli to convergence (Bielschowsky[19]).

Summary

From a detailed study of more than 4,000 cases, 300 typical cases have been presented to show how the various findings from near horizontal phoria and duction tests fall into three characteristic

groups: I, the normals; II, the subnormals; III, the abnormals.

Certain evidence is presented to suggest that, basically, group III may resemble group II.

The relation of the base-in reading at 13 inches to the interpupillary distance is emphasized.

The effect of cycloplegia on the findings is shown not to be dependable even though the tendency of cycloplegia to cause a reduction in the convergence activity is suggested.

Conclusions

The possibility of obtaining consistent dependable muscle findings exists, if attention is given to near horizontal phoria and duction tests.

These findings permit classification, with a resultant opportunity of studying the characteristics of the groups.

A classification is presented which the author has used for over 10 years with continued proof of its dependability.

1930 Wilshire Boulevard.

References

[1] Zentmayer, W. Ametropia vs. heterophoria, etc. Jour. Amer. Med. Assoc., 1924, v. 63, Aug., p. 572.
[2] Mann, I. Convergence deficiency. Brit. Jour. Ophth., 1940, v. 24, Aug., p. 373.
[3] Bielschowsky, A. Theory of heterophoria. Amer. Jour. Ophth., 1938, v. 21, Oct., p. 1129.
[4] ——. Signs and symptoms of heterophorias. Amer. Jour. Ophth., 1938, v. 21, Nov., p. 1219.
[5] Clausen, W. The importance of fusion. Arch. f. Augenh., 1931, v. 105, Oct., p. 187.
[6] Duane, A. Norms of convergence. Contributions to Ophthalmic Science. Menasha, Wisconsin, George Banta Publishing Co., 1926, p. 34.
[7] Berens, C., Losey, R., and Hardy, Le G. H. Routine examinations of ocular muscles. Amer. Jour. Ophth., 1927, v. 10, p. 910.
[8] Sheard, C. Accommodative or physiologic exophoria. Amer. Jour. Physiol. Optics, 1925, v. 6, Oct., p. 585.
[9] Dobson, M. Convergence. Brit. Jour. Ophth., 1941, v. 25, Feb., p. 66.
[10] Weymouth, F. W., Brust, D. R., and Gobar, F. H. Ocular muscle balance, etc. Amer. Jour. Physiol. Optics, 1925, v. 6, Apr., p. 184.
[11] Maxwell, J. Outline of ocular refraction. Omaha, Nebraska, Medical Publishing Company, 1937, p. 189.
[12] Banister, J. M. Hints in relation to dynamics, etc. Amer. Jour. Ophth., 1920, v. 3, Dec., p. 878.
[13] Maxwell, J. Nature and management of heterophorias. Arch. of Ophth., 1938, v. 20, Sept., p. 375.
[14] Abraham, S. V. A new test for vertical phorias, etc. Arch. of Ophth., 1931, v. 5, May, p. 766.
[15] Pascal, J. Calculating stereoscopic vergence. Arch. of Ophth., 1934, v. 11, May, p. 807.
[16] Brown, E. V. L. Personal communication.
[17] Prentice, C. F. Quoted by Fox, L. Heterophoria. Amer. Jour. Ophth., 1923, v. 6, Feb., p. 110.
[18] Bielschowsky, A. Lectures on motor anomalies. Hanover, New Hampshire, Dartmouth College Publication, 1940, p. 105.
[19] ——. Ibid., p. 11.

STUDIES ON THE INFECTIVITY OF TRACHOMA*

XII. Additional observations on the cultivability of the virus

L. A. Julianelle, Ph.D.
Saint Louis

Preceding communications[1] from this laboratory have described the different experiments undertaken to propagate the virus of trachoma. Despite numerous trials with modifications of the methods of tissue cultures generally adopted for artificial growth of viruses, no evidence was acquired of either multiplication or even survival of the trachomatous virus in any of the procedures employed. The subsequent demonstration by Goodpasture, Douglas, and Anderson[2] that human skin may be grafted upon the chorioallantoic membrane of the developing chick embryo, suggested the possibility of grafting, in similar manner, infective conjunctiva derived from patients with active trachoma. While a comparable method previously devised in this laboratory (that is, the cultivation of normal and trachomatous conjunctiva embedded in plasma) yielded growth of the tissue but not of the virus, it was, nevertheless, considered of value to experiment with the newer technique, because it was reasoned that successful grafts on the chorioallantois might grow more vigorously and survive longer than had the cells cultivated on plasma clots *in vitro*. A number of such trials have now been made, and this communication comprises a brief report of the experiments conducted and the results observed.

Procedure

The conjunctival sac of the patient studied was first flushed thoroughly with tepid saline–boric-acid solution to reduce the number of bacterial contaminants. Under novocaine anesthesia, the conjunctiva was then scraped with a dull scalpel and the scrapings were immersed in veal-infusion broth. On returning to the laboratory the scraped tissue was washed in several rinses of sterile broth, and small particles (about 0.125 to 0.25 cm. in diameter) were flattened out in a sterile Petri dish and then transferred with a specially shortened and blunt cataract knife to the chorioallantoic membrane of eggs opened in the usual way. The eggs used for the purpose were for the most part of embryos 10 days old, although some were 8 days and others 12 days old. The conjunctival fragment transferred to the membrane was then smoothed out, and, after placing a so-called window over the opening, the eggs were incubated in the customary manner. Since the incubation period of the hen egg is about 21 days, it was possible to follow observations for 10 days or longer, thus more than doubling the time generally allowed by plasma-clot cultures.

Ten experiments of this nature were completed, and the number of eggs inoculated in each varied from 6 to 12. In some instances, tissues from different individuals were pooled; in others, cultivations were made from single patients. Simultaneously with the implantation in eggs, the infectivity of all the tissues was determined by inoculation in monkeys. After grafting, the portion of chorioallantoic membrane involved was examined routinely by sections stained with hemotoxylin and eosin and, for the detection of inclusion bodies, with phloxine-

* From the Department of Ophthalmology, Washington University School of Medicine. Conducted under a grant from The Commonwealth Fund, New York, New York.

methylene blue. In addition, a number of the membranes were inoculated in monkeys after thorough grinding, the inoculation being performed both by conjunctival swabbing and by subconjunctival injection.

Results and Comments

In each of the experiments performed, about half the inoculated eggs were examined after a five to seven days' incubation period had elapsed, and the remainder were allowed to continue their development until hatching. In this way, it was possible to prolong the period of propagation of the virus to the utmost maximum for the conditions under study. Grafts were successfully accomplished in approximately half the eggs inoculated. In such instances, the grafts were recognizable grossly as firm, moist glistening plaques of varying dimensions, while in sections they appeared to be perfectly fused with the avian tissue. On microscopic examination, moreover, epithelial pearls were encountered frequently, thus indicating the adequacy of the surrounding medium to stimulate and support active growth of the conjunctival epithelium. In other words, if multiplication of the trachomatous virus is dependent upon luxuriant cultures of the tissue, then this condition appeared to have been fulfilled. In contradistinction, unsuccessful grafts were seen as small desiccated, yellowish areas which under the microscope appeared to be undergoing necrosis. The frequent causes of failure were attributed to bacterial contamination, excessive traumatization of the conjunctiva, and thickness of the fragments inoculated.

While the original scrapings from the patients proved to be infectious for the usual proportion of monkeys studied, the ground chorioallantois and graft failed in every instance to induce experimental trachoma in any of the animals. This observation may reasonably be interpreted as a lack of effectual growth on the part of the virus under the conditions outlined. Whether it may be simultaneously assumed that the virus even failed to survive the transplantation, must remain unanswered, since the factor of dilution was sufficiently great to carry the virus beyond its range of activity.

Additional evidence of the lack of growth of the virus was forthcoming from a study of sections stained to bring out inclusion bodies. No evidence of inclusion bodies typical of trachoma was found in the epithelial cells of either the conjunctival graft or of the chorioallantoic membrane. Furthermore, free initial or elementary bodies were not seen in any of the preparations, If, therefore, the inclusion body or its independent constituents be accepted as representative of the virus itself, then this observation may be considered as supportive of the one summarized above on the noninfectivity of the grafts.

In order to prolong as far as possible the potential period of growth for the virus, some of the eggs were allowed to incubate until hatching, thus extending the interval in some cases of almost two weeks. Upon hatching, however, the chicks appeared to be normal in every way, and they developed in the regular manner for the two to three weeks following that they were kept under observation. Apparently, neither the manipulation nor the graft affected materially the development of the embryo. This observation can be regarded as additional, if inconclusive, evidence of the inability of the virus to propagate itself in the grafted conjunctiva.

In five experiments, inoculations of ground scrapings were made into the yolk-sac, in accordance with the technique recommended by Cox[3] for the cultivation of the rickettsiae of Rocky

Mountain spotted fever. In none of these trials was it possible to demonstrate that growth of the virus had taken place, either by microscopic examination or by animal inoculation. This is in verification of a previously published opinion[4] disavowing the rickettsial nature of the infectious agent of trachoma.

It appears, therefore, that two different methods have now been employed in this laboratory for the artificial proliferation of human conjunctiva containing demonstrable trachomatous virus. Both methods have been successful in maintaining growth of conjunctival epithelium, which is universally accepted as the natural habitat of the virus. Of the two procedures, grafting of the tissue on the chorioallantois is apparently preferable to embedding in plasma, since the former is simpler to perform, yields a more vigorous growth, and offers a longer period of observation. Yet, in spite of active growth on the part of the conjunctival cells, the virus originally present failed to multiply, at least to an extent detectable by microscopic appearance or animal virulence.

Two possible factors suggest themselves in explanation of the failure of the virus to propagate itself. First, the virus is of exquisite selectivity and, therefore, capable of infecting only the epithelial cells of the anterior segment of only man, apes, and monkeys. Consequently, while the cells cultivated artificially are still conjunctival cells, there may have been sufficient, albeit subtle, change to alter for the virus the preëxisting nutritional properties of the cells. Second, the incubation period observed in both spontaneous trachoma of man and experimental disease of monkeys is excessively prolonged, frequently extending to a full month. This implies that the virus has a retarded interval of lag and requires more time for its development than that offered either by the *in vitro* plasma-clot method (about five days) or by graft in the fertile hen egg (about 10 days, occasionally more). If the two considerations actually represent the difficulties involved, then it must be admitted that propagation of the virus of trachoma has, indeed, a pessimistic future.

Summary

Human conjunctival cells containing demonstrable trachomatous virus have been grafted successfully upon the chorioallantois of the developing chick embryo. Proliferation of the epithelial cells was not accompanied by multiplication of the virus itself, as judged by animal inoculation and microscopic examination. Direct injections of macerated infective tissues into the yolk similarly failed to support detectable propagation of the virus. As possible explanations for this failure are offered the exalted specialization of the virus and its prolonged period of lag.

The Public Health Research Institute of the City of New York, Inc., Foot of Fifteenth Street.

References

[1] Julianelle, L. A., Harrison, R. W., and Morris, M. C. Jour. Exp. Med., 1937, v. 65, p. 755. Harrison, R. W., and Julianelle, L. A. Amer. Jour. Ophth., 1937, v. 20, p. 360.
[2] Goodpasture, E. W., Douglas, B., and Anderson, K. Jour. Exp. Med., 1938, v. 68, p. 891.
[3] Cox, H. R. Pub. Health Rep., 1938, v. 53, p. 2241; also Science, 1941, v. 94, p. 399.
[4] Julianelle, L. A., and Smith, J. E. Amer. Jour. Ophth., 1940, v. 23, p. 64.

METASTATIC PANOPHTHALMITIS FOLLOWED BY RETINAL SEPARATION AND RECOVERY

HUGH C. DONAHUE, M.D.
Boston

The occurrence of severe metastatic panophthalmitis without subsequent loss of the eye or at least substantial impairment of vision happens so infrequently that such a case merits consideration and report. These cases formerly resulted almost universally in disaster. Duke-Elder in discussing suppurative panophthalmitis states that "at an early stage vision is rapidly reduced and ultimately is completely and irrevocably destroyed, the common result being a complete and atrophic degeneration of the globe with shrinkage." This has been such a universal experience in this type of case for so many ophthalmologists that a contrary result due to more modern medication is not only revolutionary in a medical sense but obviousy extremely beneficial to the patient.

Etiology. In the metastatic type of panophthalmitis the causative factor reaches the eye through the vascular system, probably in the form of bacterial emboli; these become lodged most commonly in the anterior choroidal blood vessels and from this site infection spreads, involving all the other ocular tissues. Bacterial examination of many cases reveals the offending organisms, listed in the order of their frequency of attack, to be streptococcus, pneumococcus, staphylococcus. gonococcus, and a mycosis or fungus infection. Bacterial emboli may also infect the eye when they result from the presence of any of the entire roster of infectious diseases, the most common being syphilis, tuberculosis, leprosy, puerperal fever, septicemia, and so on through the list of pyemic conditions.

Pathology. The transmission of a septic embolus through the blood stream to the eye usually tends to produce an acute purulent inflammatory process which soon involves the entire globe. This rapid extension of infection is possible both because of the close relationship of the vascular system of the different parts of the uveal tract and because of the constant interchange of the intraocular fluids, which makes extension of an inflammatory process more likely. Most pathologists report a marked hyperemia of the central blood vessels of the choroid, accompanied by dilatation and engorgement of these vessels with erythrocytes and leucocytes as the first histologic evidence of infection; there follows obstruction of the blood vessels, oftentimes due to pyemic thrombi or masses of fibrin, leucocytes, and bacteria, resulting in stoppage of the circulation and exudation into the surrounding tissues, with hemorrhage. Subsequently the adjacent tissue cells and the pigment cells become swollen and show necrotic changes and then, both because of the cessation of circulation and the pouring forth of intense amounts of bacterial toxins, the entire tissue becomes necrotic and degenerates. This type of pathologic process takes place in each part of the uveal tract, extending to other parts of the eye, and eventually results in complete disorganization of the globe and phthisis bulbi. If, by any chance, the eye is saved without undergoing a substantial amount of atrophy, the usual sequence is detachment of the retina, due to contraction of bands of organized fibrous tissue in the vitreous which are the result of the intense inflammatory reaction in that chamber. This condition may also gradually progress over a period of years to phthisis bulbi.

Course. The onset of the condition is usually fairly rapid, being first characterized by pain, malaise, and headache together with visual blurring; the lids become swollen and reddened in association with chemosis of the bulbar conjunctiva that occurs usually below, but soon involves the entire tissue. A mucoid, stringy discharge may be present and soon, as the inflammation extends, the eye becomes proptosed, and limitation of motion, extreme chemosis, and pain ensue. The cornea may now become hazy and infiltrated; the limbal areas are obliterated from view by chemotic bulbar conjunctiva; the aqueous becomes turbid, and hypopyon may develop. The iris pattern is lost, this tissue becoming muddy, presenting marked vascular congestion: A gray-black reflex is seen in the fundus, later becoming yellowish, due to pus formation in the vitreous. The pain and general discomfort of the patient now increase and the temperature is elevated. This state of affairs may prevail for several days until perforation of the globe occurs, due either to necrosis of the completely abscessed cornea or sclera with drainage of pus, or the accomplishment of this condition by surgical interference. Immediate relief from pain now is experienced, and is followed by gradual shrinkage and contraction of the globe with resultant loss of vision and function of the eyeball.

The aforedescribed course of events has been so common in cases of this type that any variation from such a discouraging and useless result is worth recognizing; in my case I believe the process was brought to a halt before it reached the definitely purulent stage by the employment of sulfadiazine therapy in massive doses. Following several days of a high concentration of this drug in the blood the inflammatory process receded, leaving in its wake a retinal separation involving the inferior temporal quadrant of the fundus and extending nasally to about the 4-o'clock position; there was, however, no evidence, ophthalmoscopically, of organized traction bands of fibrous tissue in the vitreous, which have been reported as the cause of retinal separation in this condition. Rather, it was due, I believe, to the transudation of fluid from the choroid during the severe inflammatory reaction that resulted from the original transmission of bacterial emboli to the uveal tract. This retinal separation was operated on in the usual manner, following careful preoperative study, and after an uneventful convalescence and a follow-up period of six months this patient now has a useful and functioning eye that offers a striking contrast to the results previously obtained in similar overwhelming intraocular infections.

Case report. Mr. A. K., aged 52 years, an automobile worker whom I was requested to see in consultation at a private hospital on May 22, 1942, had had a transurethral prostatectomy performed 10 days previously. He had been convalescing uneventfully until seven days following the operation, then began to note some pain and irritation in the region of the right eye. Eight days after the operation there was some swelling and redness of the lids, and the patient had a sensation of grittiness and sandiness in the eye. This condition persisted for two days, associated with a gradual increase in the pain and congestion of the eye.

Upon first examination vision in the right eye sufficed to count fingers at 10 feet. There was a moderate amount of redness and edema of the upper and lower lid of the right eye together with a small amount of chemosis of the lower bulbar conjunctiva. The cornea was normal. The pupil measured 4 mm. in size, reacted normally to light and accommodation, and a normal red reflex was seen

in the fundus; the vitreous, however, contained many dustlike opacities, and a grayish slate color was seen in the inferior nasal quadrant.

Antiseptic solutions and ointments were prescribed, to be used together with warm compresses, but upon the following day the redness and edema of the lids were much more marked. The eye was proptosed 4 mm. and was limited as to motion in all directions. Vision was now good light projection in all fields. The chemosis of the bulbar conjunctiva had increased, although the cornea remained perfectly clear. The pupil was widely dilated, following the instillation of a mydriatic. The red reflex that had been seen upon the day before was no longer visible, and the fundus appeared grayish black in color.

The urologic condition of this patient was entirely satisfactory, although the prostate gland had contained many leucocytes and lymphocytes previous to the operation. It was thought that this condition represented a beginning metastatic endophthalmitis, and both urologic and otolaryngologic consultants were called.

X-ray films of the accessory nasal sinuses were obtained and reported negative and the otolaryngologic consultant stated that there was no active focus of infection in the sinuses. The urological consultant, however, thought that the prostate gland might well be an active focus of infection. Physical examination and laboratory studies were otherwise negative.

The patient's general condition became worse as this fulminating infection of the ocular tissues spread rapidly. A high temperature and prostration marked the systemic reaction to the infection. Within the next 24 hours the lids became tremendously edematous and red, and there were massive chemosis of the bulbar conjunctiva and fixation of the proptosed eyeball. The cornea remained clear, however, and there was no hypopyon. The fundus remained a grayish black color due to the infection within the vitreous chamber.

On the day following my first examination, treatment with sulfadiazine was begun, and the blood concentration of this drug from the third to the tenth day of observation averaged 20 mg. percent. During the period extending from the fourth to the eighth day of the ocular infection, the patient's condition remained more or less at a standstill, but, beginning upon the eighth day, the acute inflammatory process gradually receded. The redness and edema of the lids slowly subsided together with the chemosis, and the patient was discharged from the hospital at the end of the seventeenth day, presenting a normal-appearing external eye. Vision was light projection good in all fields, and there was still a grayish black reflex obtained upon ophthalmologic examination of the eye.

One week later the patient was seen in my office, and his vision was 8/200. Upon examination with the ophthalmoscope, a red reflex was obtained in all fields. An extensive separation of the retina was seen extending from the lower temporal quadrant to the lower nasal quadrant and impinging upon the macular area. The patient was apprised of this condition, and it was thought, both because of its recent appearance and the absence of any organized bands of tissue in the vitreous, that some visual improvement might result from operation. No hole, however, was seen in the detached portion of the retina following several examinations, which, of course, would call for a guarded prognosis. The patient was admitted to the Massachusetts Eye and Ear Infirmary, where repeated fundus studies and other examinations were made, fields of vision were plotted and, after considera-

tion of the findings and with a careful and conservative prognosis given to the patient, operation was decided upon. On June 30th, the usual operation was performed, employing surface coagulation with insertion of Walker pins. Following a period of two weeks' convalescence in bed, examination revealed that the retina was back in good position throughout the area of previous separation.

This patient has been followed for six months since the operation, and vision at the last examination was 20/70 with glasses, with a 15-degree constriction in the upper nasal field. This represents an extremely valuable result that may be directly attributable to the employment of heroic doses of sulfadiazine therapy in a case of fulminating intraocular infection.

520 Commonwealth Avenue.

THE VITAMINS IN OPHTHALMOLOGY*

ALVIN J. BAER, MAYOR (MC), A.U.S.
Kansas City, Missouri

The public has become exceedingly interested in the subject of vitamins. There are few patients visiting the physician who do not expect and demand a prescription containing these chemical substances. There is so much heard and read of these compounds that it behooves us as doctors to acquire a clear understanding of these chemicals and to learn what may be expected of them clinically.

Vitamins have been defined as substances indispensable in maintaining health and essential for the normal growth of all living cells. Vitamins are a type of biologic catalyzer. They activate living cells to perform normal physiologic functions. Some of the vitamins have been isolated in pure crystalline form and a few have been made synthetically. In nature, vitamins are found in both plant and animal tissue. There is a definite correlation between the vitamins, the endocrines, and the heavy metals.

Sydenstricker[1] remarked that nutritional health depends not only on the ingestion of the proper quantity of various substances but also on their assimilation, utilization, and in many instances on their storage in the tissues. Therefore, if the body because of disease, is incapable of making use of vitamins, the patient will develop the signs and symptoms of vitamin deficiency even though given a plentiful supply orally. This is not an uncommon occurrence during fevers or in toxic states that quickly claim the normal supply. This fact has been noted by Goldberg and Schlivek,[2] who reported no improvement in patients who were given large amounts of vitamins orally but who showed remarkable improvement when these substances were given intramuscularly.

In spite of the enormous amount of research, little is as yet definitely known about the vitamins. Many new ones are constantly being discovered and ideas concerning them are in a state of flux. The function of one vitamin may be seriously impaired by the absence of another and there is reason to believe that some vitamins act as catalyzers to others. Clements and Searcy[3] state that the vitamins have a strong affinity for each other, and large amounts of one may lead to de-

* Read before the Kansas City Society of Ophthalmology and Otolaryngology in March, 1942.

pletion of others. Therefore, the trend is away from prescribing vitamins in a single pure form and back to including the whole group or complex. If the patient is deficient in one vitamin, he is apt to be deficient in others.

Typical cases of vitamin deficiency are rare in this country, but Yudkin[4] points out that avitaminosis as a complication of other diseases is relatively common. This must be borne in mind when we restrict the diets of old people after intraocular operations.

Vitamin A

As early as 1500 B.C. night blindness was recognized and cured by adding liver to the diet, and xerophthalmia has been known from early times. The importance of vitamin A was recognized in 1917, when Dutch children given margarine developed xerophthalmia.[5]

Vitamin A is an alcohol and can be obtained in crystalline form. The main precursor in vegetable foods is beta carotene, and for absorption into the body the presence of bile salts is necessary.[6] Liver is especially rich in vitamin A as such. This vitamin is soluble in oil. Carotene is found in carrots, in green and yellow vegetables, in fruits, and in fish-oil products. Fat-soluble vitamin A is stored in the liver, whereas carotene, to be stored, must first be converted into vitamin A.[7] This vitamin is essential in keeping epithelial tissues in a state of health.

It has long been known that visual purple (rhodopsin) is contained in the rod cells of the retina. This substance is extremely sensitive and becomes bleached and inert when exposed to light but is again restored when the eye returns to normal. Vitamin A is taken from the blood by the retina presumably by the cells of the first pigment layer and later by the rods, where it is stored and combined with protein to form the visual purple. This when exposed to light changes to visual yellow and retinene. The visual yellow and perhaps the retinene change back partly to vitamin A and partly into waste products which pass into the blood. In the case of vitamin A the cycle is again completed.[8]

The researches and writings of Pillat are so exhaustive and are so well known that only a brief résumé of the symptoms and signs of vitamin-A deficiency is needed here. Pillat classified them (as summarized by McDonald and Adler)[9] in the order of their appearance as follows: night blindness, xerosis of the conjunctiva, loss of luster and wrinkling of the conjunctiva with Bitot's spots, xerosis of the cornea with loss of luster and sensation, and true keratomalacia with perforation, corneal opacity, and ensuing blindness. He also mentioned pigmentation of the cornea, meibomianitis, blepharitis, hordeoli, decrease in tears, edema and puffiness of the lids, and the formation of dry, rough skin covered with comedons.[3] It has been stated that the nasal mucous membrane is affected before and recovers after the ocular mucosa.

Asthenopia caused by vitamin-A deficiency is manifest by photophobia, pain in the eyes after use for short periods, blurring of print, and chronic conjunctivitis. The principal lesion is the keratinization of epithelial cells, which is shown by cornification and a skin rash consisting of papules and pustules, retardation of growth, weakness, loss of weight, and an increased susceptibility to infections of the mucous membranes.[10] It had formerly been thought that the presence of vitamin A prevented infection. This belief has been changed, and it is now thought that infection is frequent in vitamin-A deficiency, due to the general lowering of the body's resistance and not *per se* to the lack of vitamin A.

Poor dark adaptation, due to patho-

logic changes in cases of retinitis pigmentosa, toxic amblyopia, detached retina, choroiditis, glaucoma, and liver damage, is not benefited by the addition of vitamin A, whereas all cases of functional or latent night blindness may be assumed to be due to vitamin-A deficiency.

De Grosz[11] advocates the application of vitmain A locally to the cornea to promote epithelization in fresh corneal wounds. This was first tried by the Russians. Very large doses of vitamin A have been given without noticeably bad effect. The vitamin-A requirement is 5,600 I.U. a day, but in case of disease much higher amounts may be needed. It has been found that the addition of minute doses of a compound iodine solution greatly adds to the efficiency of vitamin A.[12]

Vitamin B

At least seven factors are classified under vitamin-B complex that are necessary for animal existence.[4] However, only two of these are known to influence the ocular organ. The factors in this complex are water soluble[13] and are intimately concerned with the derivation of energy from carbohydrates. They function as activators of coenzymes and promote gastrointestinal functions.[10] They are essential to intracellular respiratory processes, are unstable in alkaline media, and are rapidly changed into an inactive phase by light.[14] These factors are found in meat, potatoes, green vegetables, and yeast. They are not stored up in the body, so that a continuous supply must be constantly ingested.

Vitamin B_1 is the antineuritic or beriberi-preventing factor. The pure crystalline product is known as thiamin chloride. It acts as a catalyzer in the combustion of carbohydrates, which, in its absence, is arrested in the pyruvic-acid stage. This has a toxic effect on nerve tissue. It is of value in correcting anorexia of dietary origin, in procuring optimal growth in infants and children, and in preventing the vomiting of pregnancy.[4]

Vitamin-B_1 deficiency in man causes noninflammatory peripheral neuritis and paralysis, but does not cause nerve degeneration. This fact could explain the rapid improvement that is observed when thiamin chloride is given in the treatment of these conditions. Neuritis is apt to occur in the presence of noxious substances such as alcohol, excessive blood sugar, or from the toxins of pregnancy. The gastrointestinal symptoms include either hypermotility or hypomotility and anorexia, but no specific lesion has thus far been found. Severe deficiency causes enlargement of the right side of the heart accompanied by palpitation and dyspnea. In the eye, thiamin chloride is efficacious in tobacco-alcohol amblyopia, which has been reported cured even though the consumption of tobacco and/or alcohol was not curtailed. The chronic alcoholic relies more and more on alcohol alone for his energy and food requirements, so that his diet becomes greatly deficient in vitamins, and since the B complex is not stored up in the tissues, there is no reserve from which such a person may draw.

Nitzulescu and Triandaf report good results from the use of thiamin chloride in cases of herpetic keratitis.[15]

The amount of thiamin chloride eliminated by way of the kidneys is used as an index in the diagnosis in cases of vitamin-B_1 deficiency. The body requirements relative to weight and to the calcium intake is a minimum of 300 I.U. or 1 mg. per day for the prevention of beriberi.

Vitamin B_2 is the antipellagra factor. It consists of two vitamins, nicotinic acid and riboflavin. Vitamin B_2 combines in the body with protein to form a ferment concerned with cell respiration,[13] and is

essential to body growth and to normal nutrition. It has been shown that to be most effective vitamin B_2 must usually be accompanied by vitamin B_1; for the factors of the B group exert their best action when given together.[16] Lack of vitamin B_2 causes digestive disturbances, nerve depression, general weakness, unhealthy skin, increased incidence of infection, and diminished vitality.[4]

The first picture of ariboflavinosis was given by Sebrell and Butler.[17] They noted redness of the buccal surfaces and lips, accompanied by desquamation; maceration of the commissure of the lips with fissures and rhagades; seborrhea of the nasal folds, eyelids, and ears; seborrhea and follicular keratosis on the malar prominences and chin; and a specific type of glossitis consisting of clean, flattened, or mushroom-shaped papillae.

The first observations of ocular changes due to vitamin-B_2 deficiency were made in 1940 by Kruse, Sydenstricker, and Sebrell.[18] They believed that riboflavin in intracellular respiration acts as a carrier of oxygen from the superficial layers of the corneal epithelium to the deeper layers, since the normal cornea has no blood supply of its own. Therefore, lack of vitamin B_2 causes cell asphyxiation, which in turn, causes vascularization of the cornea as a defense mechanism.[19] Kruse, Sydenstricker, and Sebrell's patients were given thiamin chloride, nicotinic acid, cevitamic acid, and cod-liver oil in an attempt to bring out the symptoms and signs of pure riboflavin deficiency. By regulating the dose of riboflavin they were able to institute cures or to cause relapses at will.

They list, as common symptoms of vitamin-B_2 deficiency, itching, burning, and a sensation of roughness in the lids together with mild photophobia; severe photophobia with decreased vision in poor light was noted as less common. The principal manifestation of ariboflavinosis is keratitis, and Kruse and his co-workers were able to show that the corneal lesions decreased or disappeared on the administration of riboflavin only to return when this therapy was withheld.

The earliest change in the cornea, observable with the slitlamp, is a superficial invasion of the corneal capillary vessels. Later, extensive interstitial infiltration with the formation of exudates appeared, and, finally, iritis. Two cases of ocular lesions associated with lues improved markedly under riboflavin, after antiluetic therapy had failed to bring a response, and it was supposed that luetic interstitial keratitis was due to asphyxiation of the corneal epithelium.

Callahan[20] believed that vitamin G is useful in the prevention of cataract, and Day, Langston, and O'Brien[21] noted the consistent appearance of cataracts in control rats fed on a diet deficient in vitamin B_2, whereas rats fed riboflavin failed to develop cataract. However, Tainter and Borley[22] were unable to induce cataract in rats fed on diets lacking in vitamin B_2, and the literature yielded nothing to show that persons with senile cataract were deficient in this factor. O'Brien was unable to arrest the progress of cataract at any stage by giving riboflavin. However, Yudkin[23] reported improvement in cases of immature cataract when B complex and lemon juice were prescribed. These conflicting observations need time and further research before a fair valuation can be placed on the efficacy of the vitamins in the influencing of cataract.

Hohn[19] found the following changes in the eyes of experimental animals deprived of vitamin B_2: swelling of the lids, opacities in the lens, cataract, vascularization of the cornea, conjunctivitis and blepharitis, and corneal ulceration. Alopecia with loss of the lashes has been noted and

phlyctenular keratoconjunctivitis has been attributed to a lack of vitamin B_2 in the diet.

The amount of riboflavin excreted in the urine is taken as an index of oral consumption. The initial dose should be high, and the daily dose should average about 5 mg. by mouth. According to Veasey[13] the daily requirements are about 2 or 3 mg. of vitamin B_2. Sydenstricker and his co-workers suggest a possible relationship between riboflavin and vitamin A.

Vitamin C

Vitamin C, the antiscurvy vitamin, in pure form is hexuramic acid, which later has been termed ascorbic and cevitamic acid. It is essential for the maintenance of the intercellular cement substance between endothelial cells, and is an important factor in tissue respiration. Lack of this factor causes increased capillary fragility and a tendency to hemorrhage.[10] This is the vitamin found in citrus fruits. Abt and Farmea[24] found consistently low values of vitamin C in patients suffering from mild coryza, acute pharyngitis, chronic otitis media, and acute respiratory infections. The normal lens and aqueous are rich in vitamin C.

Yudkin, as reported by Goldberg and Schlivek[2] has shown that the cataractous lens has a greatly diminished amount of vitamin C, and Bietti[25] stated that the amount of vitamin C is much less when the lens is removed, but that the amount is not so dependent on the presence of the lens as on its vitality. Bellows[26] has shown that the administration of cysteine and to a lesser extent of vitamin C delayed the onset of cataract in experimental animals.

The human lens contains about 31 mg. of vitamin C per 100 grams of weight. This is reduced to as little as 5 mg. in the cataractous lens. However, the reduced amount of vitamin C found in opaque lenses may be the result rather than the direct cause of the cataract. This observation seems to be substantiated by tissue saturation of the vitamin-C content as measured in the urine and blood. This view is sponsored by Hawley and Pearson,[27] by Laval,[28] and others. Urbanek[29] could find no evidence of satisfactory results when endeavoring to clear up lenticular opacities by administering vitamin C.

Vitamin C is used advantageously in hemorrhagic retinitis, but Yudkin[4] and others have observed that synthetic cevitamic acid is not so efficacious as are the juices of citrus fruits, especially when the pulp or part of the rind is included. Patients suffering from purpura were not improved by taking cevitamic acid, but were markedly improved by the ingestion of peppers and citrus fruits.[28] It has but recently been discovered that citrin or vitamin P, found most abundantly in the rind and pulp of citrus fruits and peppers, exerts a helpful effect on petechial hemorrhages as well as on intraocular hemorrhages.[6]

Vitamin D

Vitamin D, known as the antirachitic or sunshine vitamin, is stored in the liver and is important in the relationship to body calcium and phosphorus. It is most abundant in fish livers and is fat soluble. Holt[10] enumerated the ocular changes found in vitamin-D deficiency as corneal changes, consisting of thinning of the epithelium and edema of the stroma. However, she was unable to find any specific use for this vitamin in the eye.

Blackberg and Knapp[30] made experiments on young dogs kept on a diet low in vitamin D and calcium, and noted prominence of the eyeballs, widening of the palpebral fissures, episcleral injection, primary ectasia of the cornea, deepening of the anterior chamber, and swelling and discoloration of the iris. Laval,[31] treating myopia in 48 patients up to 17 years

of age, gave 10 drops of viosterol daily, plus one quart of milk for the calcium. These patients were seen every nine months for from three to six years, and the results tended to show that this form of therapy was ineffectual in preventing an increase in myopia.

A. A. Knapp[32] used vitamin D in 46 cases of progressive myopia with the following results: Twelve showed a decrease in refraction, in two the condition remained stationary, and in four it progressed. He concluded that a disturbance in the vitamin-D–calcium-phosphorus metabolism does affect the etiology of myopia. Low calcium has been found in myopic individuals and A. A. Knapp[32] reported that 11 patients with keratoconus were improved on vitamin-D-complex therapy.

Vitamin K

Hilgore[7] quotes Burch and Meade as reporting one case of retinal hemorrhage improved by vitamin-K therapy.

The most important element in the treatment of vitamin deficiency, according to Clements and Searcy,[3] is the diet. If the faulty diet, these authors state, is not corrected after the deficiency is dissipated by giving these vitamins, recurrences will invariably result in from 12 to 15 weeks. It can readily be seen by a perusal of the literature that the subject of the vitamins in ophthalmology is still a controversial one, and much more research must be done before it will be possible to evaluate the action of these substances in the ocular organ.

Jefferson Barracks, Missouri.

References

[1] Sydenstricker, V. T. Changing concepts in deficiency diseases. Jour. Med. Assoc. Alabama, 1939, v. 9, Oct., p. 105.

[2] Goldberg, H. K., and Schlivek, K. Necrosis of the cornea due to vitamin A deficiency. Arch. of Ophth., 1941, v. 25, Jan., p. 122.

[3] Clements, R. M., and Searcy, H. B. Use of vitamins in eye, ear, nose and throat practise. Jour. Med. Assoc. Alabama, 1939, v. 9, Oct., p. 100.

[4] Yudkin, A. M. Vitamins in the treatment and prevention of ocular disease. Arch. of Ophth., 1938, v. 19, March, p. 366.

[5] Langdon Brown, Sir W. Hormones and vitamins in ophthalmology. Trans. Ophth. Soc. United Kingdom, 1938, v. 58, pt. 2, p. 454.

[6] Barker, L. F. The diagnosis and treatment of vitamin deficiencies. Jour. Iowa State Med. Soc., 1940, v. 30, Jan., p. 1.

[7] Hilgore, B. F. Vitamins in ophthalmology. Jour. Iowa State Med. Soc., 1940, v. 30, p. 304.

[8] Cordes, F. C., and Harrington, D. O. Asthenopia due to vitamin deficiency. Amer. Jour. Ophth., 1939, v. 22, p. 1321.

[9] McDonald, R., and Adler, F. H. The effect of anoxemia on dark adaptation of the normal and the vitamin deficient subject. Arch. of Ophth., 1940, v. 24, p. 447; and Arch. of Ophth., 1940, v. 24, p. 1258.

[10] Holt, Helen. Role of vitamins in ophthalmology. Illinois Med. Jour., 1939, v. 75, May, p. 458.

[11] de Grosz, S. Local use of vitamin preparations in ophthalmic practise. Arch. of Ophth., 1939, v. 22, Nov., p. 727.

[12] Feldman, J. B. Dark adaptation, night blindness and glaucoma. Arch. of Ophth., 1939, v. 22, Oct., p. 595.

[13] Veasey, C. C. Vitamin in ophthalmology. Arch. of Ophth., 1941, v. 25, March, p. 450.

[14] Sydenstricker, V. T., Kelly, A. R., and Weaver, J. W. Ariboflavinosis with special reference to the ocular manifestations. Arch. of Ophth., 1941, v. 34, Feb., p. 165.

[15] Nitzulescu, J., and Triandaf, E. Treatment of herpetic keratitis with vitamin B. Brit. Jour. Ophth., 1937, v. 21, Dec., p. 654.

[16] Grosz, S. The importance of vitamin B in ophthalmology. Graefe's Arch., 1937, v. 140, pt. 1, p. 149.

[17] Sebrell, W. H., and Butler. Reaction to oral administration of nicotinic acid. Jour. Amer. Med. Assoc., 1938, v. 111, Dec. 17, p. 3386.

[18] Kruse, H. D., Sydenstricker, V. T., and Sebrell, W. H. Ocular manifestations of ariboflavinosis. Public Health Reports, 1940, v. 55, Jan., p. 157.
[19] Hohn, H. C. Riboflavin deficiency among the Chinese—Ocular manifestations. Chinese Med. Jour., 1940, v. 58, Dec., p. 616.
[20] Callahan, A. Avitaminosis in eye disorders. The Mississippi Doctor, 1940, v. 17, May, p. 667.
[21] Day, P. L., Langston, W. C., and O'Brien, C. S. Amer. Jour. Ophth., 1931, v. 14, p. 1005.
[22] Tainter, M. L., and Borley, W. E. Influence on vitamins and dinitrophenol in production of experimental cataract. Amer. Jour. Ophth., 1938, v. 21, Oct., p. 1091.
[23] Yudkin, A. M. Diet and vitamins in relation to cataract. Amer. Jour. Ophth., 1938, v. 21, Aug., p. 871.
[24] Abt and Farmea. Invalidation of plasma ascorbic acid values by use of potassium cyanide. Proc. Soc. Exper. Biol. and Med., 1938, v. 38, Apr., p. 399.
[25] Bietti, G. Vitamin C in ocular tissues and liquids. Its relation to the biology of the lens. Boll. d'Ocul., 1935, v. 14, Jan., p. 3.
[26] Bellows, J. G. Effect of cysteine hydrochloride on conjunctiva. Arch. of Ophth., 1937, v. 18, July, p. 76.
[27] Hawley, E. E., and Pearson, O. Vitamin C. Its relation to cataract. Arch. of Ophth., 1938, v. 19, June, p. 959.
[28] Laval, J. Vitamin therapy in ophthalmic practice. Amer. Jour. Ophth., 1940, v. 23, p. 33.
[29] Urbanek, J. The C vitamin. Metabolism of cataract patients. Klin. M. f. Augenh., 1938, v. 101, Nov., p. 67.
[30] Blackberg, S. N., and Knapp, A. A. Amer. Jour. Ophth., 1937, v. 20, p. 405.
[31] Laval, J. Vitamin D in myopia. Arch. of Ophth., 1938, v. 19, Jan., p. 47.
[32] Knapp, A. A. Amer. Jour. Ophth., 1939, v. 22, p. 289.

CONCERNING LAGRANGE'S LAW OF INDIRECT OCULAR WAR INJURIES

PETER S. SOUDAKOFF, M.D.
Los Angeles

Of 48,290 American patients with war injuries admitted to Casualty Clearing Station in 1918, 1.5 percent suffered from injuries to the eye.[1] It may be expected that during the present war the number of casualties, and corresponding injuries to the eye, will be more numerous.

Indirect war injuries to the eye have attracted the attention of the surgeons for a long time; very valuable contributions on this subject were published by Berlin during the Franco-Prussian war. During the last European war, injuries to the eye were studied in all belligerent countries, and the casuistic literature on this subject is copious. Lister, in Great Britain,[2] and Whitham[3] and de Schweinitz,[4] in the United States, have contributed new data on the indirect injuries to the eye. Lister and de Schweinitz have summarized their own experience in war injuries to the eye, and Doherty[5] has recently reviewed the literature on the ocular injuries in war. Most comprehensive studies were carried by A. von Szily in Germany and by Felix Lagrange in France. Von Szily[6] published an "Atlas of eye diseases in war" that contains detailed descriptions of cases, pictures of fundi, and pictures of histopathologic specimens. The cases were classified according to the type of causative projectiles and, partly, according to the character of injuries. Lagrange[7] has collected 100 cases of indirect ocular injuries and grouped them according to the injuries sustained by the facial bones and by the skull.

Although Whitham and de Schweinitz praised Lagrange's contribution, and McKee[8] and recently Doherty have called Lagrange's law to the attention of the American ophthalmologists, as far as my knowledge goes, it has not received sufficient appreciation in the English-speaking countries. Nevertheless, its practical value cannot be overemphasized, for an ophthalmologist familiar with its principles is able not only to explain the loss of vision, but is also in a position to foresee the lesions of the fundus.

Lagrange reached the conclusion that precise determinism (a real law) exists between the various traumatisms of the facial bones and the diverse ocular lesions. At first he divided war injuries to the eye produced by contusion and concussion into six groups and drew up six laws, but later he reclassified these injuries into four groups and accordingly formulated four laws[9] as follows:

The *first group* of cases and the First Law are concerned with the fractures of the cranial vault that extend to the optic canal. The optic nerve is either compressed by bony fragments or damaged by traumatic shock. Atrophy of the optic nerve rapidly develops. Hemorrhage into the sheath of the optic nerve is a common complication of this injury. This law was established by Berlin in 1870.

The *second group* of cases and the Second Law comprise macular lesions and paramacular tears consequent upon trauma of the facial bones while the orbital wall remains intact. The primary cause of the lesion is concussion of the eyeball.

The *third group* of cases and the Third Law include injuries to the facial bones with the involvement of the orbital wall.

Concussion of the eyeball associated with these fractures produces two lesions: a rupture of the macula, and rupture of the choroid in front of the bony lesion (lesion by "contact"). These lesions usually develop into chorioretinitis proliferans.

The *fourth group* of cases and the Fourth Law are concerned with the cases in which a projectile has passed through the orbit behind the eyeball. If a projectile encounters the optic nerve, a complete disinsertion of the head of the optic nerve occurs; if a projectile passes above or below the optic nerve, a partial avulsion of the optic nerve takes place.

Discussion

If the cases of indirect injuries, described in v. Szily's Atlas, are studied from the point of Lagrange's classification, each case will be found to correspond to one of Lagrange's four groups.

Cases 15, 16, and 21 illustrate Lagrange's *First Law.*

Case 16. Fracture of the frontal bone by a piece of grenade. On autopsy a fracture of the posterior orbital wall and a hematoma of the optic nerve were found.

Cases 55, 56, 101, and 108 correspond to Lagrange's *group two*—injury to the facial bones without fracture of the orbital wall. In all these cases the fundus presented either a picture of Berlin's opacity of the macula with its consequent degeneration or a hole of the macula.

Case 56. Contusion by explosion of a grenade. Retinal hemorrhage and degeneration of the macula.

Case 108. A bullet entered the left ear and emerged on the left nasal side, passing through the maxilla. Cloudy swelling of the retina and incomplete "hole of the macula."

Numerous cases related to *group three* are represented in v. Szily's Atlas; namely cases 42, 43, 50, 52, 53, 69, 88, 101, 102, 103, 104, 105, 106, 107, 109, and 141. In all of them rupture of the macula and rupture of the choroid were found.

Case 103. A bullet entered the right lacrimal region and came out three centimeters below the left ear. R.E., normal; L.E., papilla is atrophic. Chorioretinal rupture in the lower half of the fundus and in the macular region. New-formed connective tissue covers the greater part of the rupture.

Case 53. A splinter of shrapnel entered the middle third of the right lower lid and lodged in the outer posterior portion of the orbit. Rupture of the macula (concussion) and a chorioretinal rupture below the disc (lesion by contact).

Several cases of avulsion of the optic nerve caused by passage of a missile through the orbit behind the eyeball have been reported by v. Szily; namely, cases 22, 44, 93, and 122 (*fourth group* of Lagrange).

Case 44. A bullet entered at the middle part of the cheek and lodged in the sphenoidal fissure of the orbit. Partial avulsion of the papilla.

Case 93. A bullet entered the head through the left side of the bridge of the nose and found exit through the right ear. R.E., avulsion of the optic nerve and papilla.

Three cases reported in v. Szily's Atlas do not fit into Lagrange's classification. In cases 99 and 100 facial bones were fractured, but there was no lesion in the macular area. In case 119 no rupture of the macula or choroid occurred in spite of the fracture of the anterior orbital wall. In a few of Lagrange's own cases there is also some discrepancy

in relation to his classification and laws; although in cases 33, 36, 37, 39, and 60, the orbital wall was fractured but no rupture of the choroid occurred. Equatorial choroiditis was present without evidence of rupture; in the macular region was found either hemorrhage or chorioretinal changes. In some of these cases a partial or complete atrophy of the optic disc developed. The aforementioned three cases of v. Szily as well as the five cases of Lagrange do not contradict Lagrange's law but suggest only that a certain amount of violence must be transmitted to the eyeball in order to produce concussion of the eyeball and the lesions connected with this concussion. According to the present concept, the mechanism of lesions of the fundus produced by concussion is governed by a physical law of air-wave pressure. "The contents of the globe being fluid, sudden impact at one spot on the surface will cause a wave of pressure to radiate through the vitreous from the point of impact. The more rapid the impact, the more forceful the wave of pressure; the slower the impact, the less forceful the pressure wave."[2] In Lagrange's cases violence of impact was sufficient to cause damage to the macula and choroid, but the wave pressure brought about by this impact was not sufficiently strong to induce a rupture of either of these two structures of the eye.

Although many observers have given credit to Lagrange's contribution on the indirect injuries to the eye, none of them have attempted to group his cases according to Lagrange's classification. McKee,[8] for example, in publishing his 28 cases of war lesions of the fundus, quoted Lagrange's six laws, but he neither analyzed them from the point of Lagrange's law nor made any comment on this law. Only in the editorial introduction do we find a remark: "These (cases) agree in the main with the observations recorded in Lagrange's Atlas."

Out of his 28 cases, 1 is direct injury to the eye, 8 cases have no sufficient description of bony injuries. The remaining 19 cases may be classified according to Lagrange's law as follows: group II, cases 3, 8, 10, 13, and 14. In all of them were found macular or paramacular lesions. Group III, cases 5, 6, 7, 11, 12, 19, 20, 21, 24, 25, 26, 27, and 28. In these cases lesions of the macula and rupture of the choroid were present.

De Schweinitz has accepted Lagrange's deductions with one exception: "There seems very little doubt that lesions of the inner eye by concussion from a distance, by a concussion transmitted through the bony facial structures and following blows on the point of the eye, by preference are located in the macula and paramacular area; that impact lesions are equatorial and always are adjacent to the site of contact; that a contact lesion may spread toward the center; that posterior pole and equatorial contact lesions may approach and join each other; and that missiles traversing posterior to the bulbus and radiating fractures of the orbital vault are responsible for most of the direct optic nerve injuries. Whether it is safe to say that impact lesions are always, or almost always, retino-choroidal and concussion lesions choroidal, as Lagrange contends, it would seem is not settled."[4] Lagrange did not stress this point in his latest version of the laws.

Conclusion

Analysis of the cases of indirect war injuries to the eye communicated by various authors discloses the existence of a distinct relationship between ocular lesions and injuries of the facial bones. The presence of the fracture of the facial bones as well as the fracture of the anterior or posterior orbital wall predicts

definite lesion of the membranes of the eye, or injury to the optic nerve, according to the laws formulated by Lagrange.

The observations of the indirect injuries of the eye during the present war will give ample opportunity for American ophthalmologists to verify the correctness of Lagrange's deduction and to modify his law according to new findings.

Summary

1. Lagrange's law of indirect injuries to the eye has been presented in its latest version.

2. Cases of indirect ocular injuries described by v. Szily and McKee have been analyzed from the point of view of Lagrange's law.

3. The cases of v. Szily and the cases of Lagrange, showing discrepancy between bony injuries and fundus lesions, have been discussed.

4. The data obtained from the analysis of the cases reported by v. Szily and by McKee have been shown to support the laws deducted by Lagrange.

700 Roosevelt Building

References

[1] Swanson, C. A. Med. Clinics North Amer., 1941, v. 25, p. 1637.
[2] Lister, W. Brit. Jour. Ophth., 1924, v. 8, p. 305.
[3] Whitham. Trans. Amer. Ophth. Soc., 1919, v. 17, p. 593.
[4] de Schweinitz, G. D. Amer. Jour. Ophth., 1919, v. 2, p. 313.
[5] Doherty, W. B. Amer. Jour. Ophth., 1942, v. 25, p. 135.
[6] von Szily, A. Atlas der Kriegsaugenheilkunde. Stuttgart, F. Enke, 1916 and 1917.
[7] Lagrange, Felix. Atlas d'Ophtalmoscopie de Guerre. Paris, Masson & Cie, 1918.
[8] McKee, S. H. Amer. Jour. Ophth., 1923, v. 6, p. 725.
[9] Lagrange, Felix. Ann. d'Ocul., 1926, v. 163, p. 81.

NOTES, CASES, INSTRUMENTS

A CONFIRMATION TEST FOR REFRACTION*

CONRAD BERENS, M.D.
New York

The confirmation test for the refractionist consists of two spheres or two cylinders one plus and the other minus mounted on one handle (fig. 1),† so arranged that the examiner may check the patient's acceptance with great facility. This arrangement of lenses not only furnishes a means of rapidly checking the patient's answers, but it is also almost an essential in the trial case unless the ophthalmologist has more than one set of trial lenses. The pairs of lenses that have been found to be most universally useful are the plus and minus 0.25D. spheres and cylinders, but the spheres and cylinders are available from 0.25D. to 1.00D.

Fig. 1. (Berens). A confirmation test for refraction.

The handle is round and knurled, 62 mm. in length, and branched at one end to support lens rings for holding 38-mm. lenses. The handle is marked to show the strength of the lenses in diopters, and the lenses are also marked, the minus in red and the plus in white. In using these tests, the plus and minus 0.25D. cylinders are held in the right hand and the spheres in the left hand, and the accuracy of the correction is checked rapidly by placing the lenses before those in the trial frame and presenting first the plus and then the minus lenses merely by twirling the handle of the instrument. At times it is advantageous to superimpose the cylinders and spheres.

35 East Seventieth Street.

* Presented before the American Ophthalmological Society, Hot Springs, Virginia, June 2, 1942. Aided by a grant from The Ophthalmological Foundation, Inc.

† Made by E. B. Meyrowitz Company, New York, New York.

REFLECTION ON THE CLINICAL USE OF ATROPINE*

SAM ENGEL, M.D.
San Francisco

In diagnostic work every oculist is accustomed to vary the strength of a mydriatic according to the circumstances; as, for instance, the age of the patient or the purpose involved. This is not so much the case in therapeutic procedures; there it has become a routine to use only one or perhaps two different strengths of atropine. If atropine is not tolerated and symptoms of hypersensitivity appear, it is replaced by scopolamine; but there,

* From the Department of Ophthalmology, Stanford University Medical School.

of course, no quantitative change is intended.

After extracapsular extraction of a cataract, a 1-percent solution of atropine is usually administered, a drop in the evening being occasionally required. When used in a 4-percent solution, the application of one drop during the day is sufficient if there is no marked iritis. On the other hand, if practically the whole cortex was removed during the operation, some eyes show almost no reaction and require only one drop of a 1-percent atropine solution once or twice during the entire after-treatment. Should the pupil remain large, there is no reason for continuing the applications. The need for each eye is, of course, different. But although the range between the amount of atropine necessary and the amount of atropine given by different physicians is relatively large, the eye usually tolerates the larger dose without untoward effect. It is understood that any rise of tension before the operation, due to primary or secondary glaucoma, indicates great caution in the use of atropine which, if possible, should be restricted to the first few days after operation, when filtration through the wound can still be assumed to continue. In intracapsular cataract with basal iridectomy or incision of the iris root, Elschnig[1] recommends only one drop of a 2-percent solution of cocaine during the first few days; in case of a conspicuously narrow pupil, if the formation of synechias between pupillary margin and vitreous body may be suspected, he recommends a 1-percent solution of homatropine and, if necessary, atropine. If the extraction is combined with a total iridectomy, homatropine or atropine is instilled.

An acute iritis certainly indicates frequent applications of atropine, but one should leave a rim of iris of at least 1½ mm., further drops should be given only if the pupil shows a tendency to become narrow. A mydriatic should not be used for an already maximally dilated pupil; it only narrows the angle of the anterior chamber unnecessarily, and may precipitate an attack of glaucoma. The same restriction holds true when an attempt is made to tear posterior synechias; indiscriminate use of atropine may cause hypertension. Much as we should try to avoid the formation of synechias, care must also be exercised to prevent an attack of glaucoma. Not posterior synechias, but a renewed exogenous factor or the flare-up of an endogenous focus is responsible for the recurrence of an iritis. The possibility of a secondary glaucoma by occlusio pupillae is no excuse for precipitating an acute attack, the treatment of which is one of our most difficult problems.

When the acute stage of the iritis is subsiding, atropine is given less often or/and may be reduced to one half, one quarter, or even less of its original strength. Distilled water and a 5-c.c. syringe are the only requisites for this purpose.

If *glaucoma* has developed in a case of *acute iritis,* and no or insufficient atropine was previously administered, therapy with atropine should be tried for a few days, depending on the degree of tension, which also will decide if further observation is justified. Although the danger to the function of the eye is not so great as in primary acute glaucoma, vision and fields must be checked at proper intervals. Because of the iritis one should try the least traumatic type of operation; for example, a paracentesis. If necessary, the wound can be reopened a day or two later, but too much atropine should not be used after the puncture of the anterior chamber; it will raise the tension more rapidly and so require a greater number of reopenings. It is true that with each emptying of the anterior chamber cells

and débris are removed, but over against this it is difficult to evaluate the fact that a secondary formation of aqueous is richer in protein; that is, is of a more viscous quality, indicating a greater amount of antibodies, but also a greater possibility of blockage.

An increased intraocular pressure is more often found in a state of *chronic iridocyclitis,* and for two reasons. Such eyes sometimes do not tolerate atropine in the strength administered. The second reason is that cyclitis has often existed for weeks or even months before medical care is solicited. Cyclitis usually does not cause pain, nor does the eye show marked redness, and a slight blur may be unnoticed or be of no concern to the patient. Then a rise in tension occurs, and pain in or above the eye brings the patient to the office. We find an increased intraocular pressure and an edematous corneal epithelium; corneal precipitates are often too fine to be noticeable through the opaque cornea. The factors suggesting a cyclitic glaucoma are: (1) the relatively slight pain, (2) the pupil though larger than the pupil of the other eye, is only of medium width, and (3) last but not least, the anterior chamber is deep. If there is any doubt about the type of glaucoma, pilocarpine may be prescribed; it usually reduces the tension to some degree and clears up the epithelium after 24 hours, when precipitates can be seen.

In these cases some authors (for example, Löhlein[2]) recommend a combination of pilocarpine and adrenalin in varying strength. I have never noted marked improvement with it; on the other hand, the inflammatory symptoms were rather increased by pilocarpine. There is no general rule in medicine, particularly not for an iridocyclitis with hypertension, each of which has its own problems. On the whole I have had best results from using the following procedure: The first day a moderate mydriasis is attempted by applying a 5-percent solution of cocaine combined with adrenalin 1:1,000, which if necessary, can be counteracted by pilocarpine. If this is tolerated, euphthalmine 1 percent is given, one to three times a day, for one or more days. In case a stronger action is desired, euphthalmine is replaced by homatropine in 1- or 2-percent solution. But even if the tension comes down to normal, the eye must always be regarded as one with a disposition to glaucoma. As there is usually little hyperemia of the iris, and exudation is often of small degree—which indicates but little tendency to the formation of synechias—in shifting from homatropine to atropine, the latter in a concentration of 1:2,000 to 1:500 is often sufficient. The course of these cases is extremely slow in most instances and they seem to be controlled, if the pupil remains dilated and the precipitates gradually decrease in amount, first changing to the pigmented or crenated form. I have always had the impression that the continuous action of a mild mydriatic gave better results than the application of a stronger one, then waiting for several days until the effect had passed off. Much patience is required on the part of the physician and patient as well, but we often lose time by hurrying, for an increase in tension damages the iris and decreases its resistance, and this and the loss of function, particularly the narrowing field, make surgery more risky. The course of an iridocyclitis is rarely to be foreseen and this sometimes makes the evaluation of our therapy difficult. It is superfluous to mention that besides the local treatment (mydriatic, bandage, heat) any etiologic factor must be treated generally and, if indicated, or if there is no contraindication, the reactive tendencies of the body may be induced and supported by parenteral protein, or fever therapy.

Two case histories may demonstrate the procedure recommended: *Case 1.* Mrs. A. S. had posterior cortical senile cataracts, that of the left eye more advanced than that of the right. On August 21, 1941, the lens of the left eye was extracted. Because of the patient's nervousness a total iridectomy was performed. The postoperative course was normal. One drop of a 1-percent solution of atropine was applied every other day. On September 15, 1941, vision O.S. was 20/15 (with correcting lens). The eye showed no reaction. On February 24, 1942, five months after extraction, the patient noticed a fog before the left eye. Vision was 20/20; there were moderately fine precipitates and a dustlike veil on the endothelium. This occurred eight days after a severe attack of angina with the temperature increased to 39.5°C. The intraocular pressure was 35 mm. Hg. The administration of 2-percent pilocarpine increased it to 50 mm. Hg (next morning). Pilocarpine 2 percent, together with suprarenin bitartrate, 3:1,000 was not tolerated subjectively; the tension remained at 40 mm. Hg. Two days later euphthalmine, 0.5 percent, was applied three times a day. After four days there was less blur, and the precipitates had decreased in amount. Tension was still around 35 mm. Hg. There were slight fluctuations in the course, but on the whole the subjective and objective findings were satisfactory, so euphthalmine was continued.

On March 13th, the ocular tension was 30 mm. Hg. By March 19th, and thereafter the tension had decreased to 20 mm. Hg. On April 6th, there was a slight flare-up of the cyclitis, with moderate increase in precipitates. Atropine, 1:2,000, was thereafter given twice a day and after two weeks reduced to once a day, then discontinued. On May 15, 1942, vision was 20/15. Locally heat was applied during all this time and aspirin was given, 5 grains three times daily. Medical examination was negative except for an accelerated sedimentation rate, and a relative lymphocytosis of the blood. The patient has now been free from symptoms for nine months.

Case 2. Mr. M. S., aged 49 years, was first seen on April 16, 1942. About two weeks previously he had noticed a "change" in the vision of his left eye. On the morning of the day of examination he had a slight pain in his left eye, after noticing a slight blurring of vision on the day before. The right eye was normal. The left eye showed moderate congestion of the conjunctival vessels; the corneal epithelium was edematous. No corneal precipitates could be seen. The pupil of the left eye was slightly larger than that of the right; the anterior chamber was of medium depth. Disc and eyeground, as far as could be seen, appeared to be normal. Vision, with correcting lenses, was R.E. 20/15; L.E. 20/25. Ocular tension was R.E. 20; L.E. 48 mm. Hg. The medical examination revealed no pathologic changes except a relative lymphocytosis of the blood.

A 2-percent solution of pilocarpine was ordered for administration twice a day, and at noon of the next day the tension had decreased to 23 mm. Hg. The epithelium was clear, and fine corneal precipitates could now be seen. One drop of a 5-percent solution of cocaine combined with one drop of adrenalin, 1:1,000, was applied three times during the day, followed by homatropine 1 percent, one drop applied twice daily, for the next two days.

On April 19, 1942, the pupil was moderately wide, the precipitates were less numerous, and the tension up again to 35 mm. Hg. During the previous day heat was applied locally and 10 c.c. of calcium gluconate administered intravenously every other day. On April 20th, atropine, 1:1,000, was prescribed, one

drop twice a day. The tension slowly lessened. Ten days later (May 1st) it was 26 mm. Hg. On May 4th and thereafter it was 20 mm. Hg. The precipitates gradually disappeared. On May 11th, the dosage with atropine was reduced to one drop a day; on May 22d to once every other day; and atropine was finally discontinued on June 2d. Vision of the left eye was 20/15.

During the course of the cyclitis a choroiditis in the form of a large edematous lesion developed above the disc. This caused a temporary reduction of vision to 20/50, and a field defect appeared in the lower nasal quadrant.

As far as surgery is concerned, it has been mentioned that in acute iritis with hypertension the operation of choice is paracentesis which "on an inflamed eye is by no means a pleasant procedure" (Gifford[3]). In chronic cases iridectomy is the logical operation, but, as Duke Elder[4] agrees, the end results are frequently not good.

The purpose of this note is to point out that in some cases of iritis it is easier to avoid an attack of glaucoma than to cure it. If hypertension of the eye has developed, particularly in chronic iridocyclitis, the end result is often better if we apply small doses of atropine and achieve a slow progress than by therapy with larger doses, which, instead of resulting in a quick improvement, aggravates the condition of the eye by further increase of tension.

350 Post Street.

References

[1] Elschnig, A. Die intrakapsuläre Starextraction. Berlin, Julius Springer, 1932.
[2] Löhlein, W., and Wegener, W. Augenärztliche Tagesfragen. Freiburg, Jos. Waibel, 1934, p. 103.
[3] Gifford, R. Treatment of secondary glaucoma. Arch. of Ophth., 1940, v. 23, Feb., p. 301.
[4] Duke-Elder, W. S. Textbook of ophthalmology. St. Louis, C. V. Mosby Company, 1941, v. 3, p. 3287.

ELECTRO-SURGICAL EXCISION OF PTERYGIUM

A New Method

Daniel B. Kirby, M.D.
New York

A pterygium is a patch of thickened conjunctiva with a vascular undergrowth extending over a part of the cornea. The membrane is usually fan-shaped, with the apex toward the pupil and the base toward the inner canthus. The leashes of vessels extend forward, invade the cornea, and interfere with its transparency. Simple excision has not proved satisfactory because of the tendency of the vessels to grow forward from the stump. Transplantation above or below has its drawbacks because of the difficulty of changing the course of the vessels and of the deformity produced by the bulk of tissue in some cases.

Recognizing the value of the high-frequency electric current in coagulating tissue and destroying blood vessels both normal and abnormal, the author has applied the principle to the excision of pterygium for the past five years. He has not been aware of others having used this procedure before him.

Technique

Local anesthesia is employed both by instillation and infiltration. The pterygium has been previously carefully studied grossly and microscopically. The head is severed from the cornea by sliding a cataract knife beneath it at the limbus

and slicing it cleanly off the cornea. If any remnants are left these are sliced rather than curetted off. Then the neck of the pterygium is picked up with toothed forceps and the body lifted from its bed on the sclera. Stevens scissors are used to dissect the mass from the sclera. The conjunctiva adherent to the body of the pterygium is to be sacrificed, but any normal nonadherent conjunctiva is to be conserved. Linear sections of conjunctiva above and below the adherent conjunctiva are made toward the semilunar fold and joined just beyond the adherent conjunctiva. The mass or body of the pterygium is then freed above and below by scissors section, leaving the base intact.

The base is severed by piercing its bulk with needles and sufficient high-frequency current used to coagulate the tissues. The vessels in a vertical line, 1 mm. wide, are destroyed. Scissors are used to cut along the coagulated line. If portions of coagulated tissue remain at the base, these are picked up and excised. About 0.5 mm. of coagulated tissue is allowed to stay. This is easily taken care of by the surrounding healthy tissues, absorption and healing proceeding without interference from ulceration or annoying slough.

The method of closing the denuded area of sclera is important, the object being to provide a cover of thin, healthy conjunctiva. The conjunctiva is dissected above and below to free it, care being taken not to include much subconjunctival tissue. It is freed by making curvilinear incisions along the limbus to a sufficient degree to permit apposition by interrupted sutures without incurring tension. It is not necessary to cover the entire area around the cornea, for epithelization develops rapidly and the surface is covered by newly formed cells which grow out from the surrounding tissues. Six-zero black-silk, or four-zero plain gut sutures may be used.

It is conceivable that the original stimulus to pterygium formation may, if still active, induce a recurrence in susceptible patients after any type of operation for removal of pterygium.

The procedure has been satisfactory from the standpoints of satisfactory removal of abnormal tissue, of removal of corneal opacity, of prompt healing without complication, of nonrecurrence, and of satisfaction to the patient. It has been used over a period of five years, is relatively simple in its application, and has given very good results in all patients.

780 Park Avenue.

MEMORY AIDS IN THE MEASUREMENT OF STRABISMUS

JOSEPH I. PASCAL, M.D.
New York

In measuring the angle of squint on the perimeter one has to make allowance for the angle gamma. Incidentally, it would save much confusion if the name of the angle were agreed upon and the same term used by all writers. The angle involved is the angle between the visual axis and the pupillary axis, the latter being the imaginary line passing through the center of the pupil normal to the cornea. This angle has been named angle kappa, but this name is not universally used, a notable exception being Dr. Peter. It is very nearly the same as the angle gamma, which is usually defined as the angle between the visual axis and the fixation axis at the center of rotation. Most writers refer to the angle involved as the angle gamma. This angle is positive when the pupillary axis (pupillary center) is temporal to the visual axis and

negative when the pupillary axis (pupillary center) is nasal to the visual axis. As a memory aid, temporal—positive; nasal—negative. Also, if when locating it on the perimeter the examiner has to move temporally to get the reflected light from his ophthalmoscope into the center of the pupil the angle is positive. If the examiner has to move nasally to place the light in the center of the pupil, the angle is negative.

Now it is easy to determine why when the angle gamma is positive the value of the angle has to be added to the amount found on the perimeter in cases of convergent squint and deducted in cases of divergent squint. Also, why when the angle gamma is negative it has to be deducted in cases of convergent squint and added to in cases of divergent squint. Those who constantly work with such measurements need no memory aid. But those who do not make these measurements often will be helped by a memory aid, which I have found very useful in teaching. The following table gives the scheme:

	Angle Gamma	*Squint*	
(1)	positive	Convergence	add
(2)	positive	Divergence	subtract
(3)	negative	Convergence	subtract
(4)	negative	Divergence	add

Convergent squint may be thought of as a positive condition, both because it is the common form of squint and also because convergence is generally referred to as a positive action. Divergent squint may be thought of as a negative condition, both because it is infrequent and also because divergence is often referred to as "negative" convergence.

Now when the angle is positive and the condition is positive as in (1) we have plus by plus which gives plus, therefore add.

When the angle is positive and the condition negative as in (2) we have plus by minus which gives minus, therefore subtract.

When the angle is negative and the condition positive as in (3) we have minus by plus which also gives minus, therefore subtract.

When the angle is negative and the condition negative as in (4) we have minus by minus which gives plus, therefore add.

Almost everybody will remember from his algebra that like signs (in multiplying or dividing) give plus, and unlike signs give minus. Two negatives, even in language produce a positive; namely, he did not miss the train, means he caught the train. Spending a few minutes thinking on the aforetabulated values in terms of plus and minus will fix them in the mind so that they may be readily applied without laborious analysis.

PARESIS OF ACCOMMODATION FOLLOWING SULFADIAZINE THERAPY

JOSEPH LAVAL, M.D.
New York

A young girl, aged 17 years, a student at one of the large Eastern colleges for women, consulted me in June, 1942, because of difficulty in reading vision. She had been refracted several weeks ago for the same complaint, and glasses were prescribed at that time. No relief had been obtained. She was wearing +0.50D. sph. for each eye and under homatropine cycloplegia I found +0.25D. ⌯ +0.25D. cyl. ax. 90° for each eye. At the postcycloplegic examination her accommodative power and extraocular-muscle balance were tested. The latter was within normal limits and her PCB was 60 mm. Her accommodation near point for each

eye separately was 15 cm. which is equivalent to 6½ diopters. Using both eyes together made no appreciable difference. The minimum accommodative power at 17 years is 9½ diopters, so that she now had 3 diopters less accommodative power than the minimum for her age and 5 diopters less than the average for her age. I prescribed +1.50D. sph. for each eye, and the patient was able to read and study again with complete comfort. Re-examination in September, 1942, and in January, 1943, showed no change in the accommodative power, the patient still having complete relief with the plus spheres.

The history I obtained at the patient's first visit in June, 1942, was that her reading difficulty began in March, 1942, immediately after she had had an upper respiratory infection for which sulfadiazine was prescribed at the college infirmary. The complete history, which I obtained from the doctor in attendance, follows:

"On February 12, 1942, the patient complained of having a slight sore throat, and sinus headache. The nose and sinuses were clear, but the pharynx showed hyperplastic, reddened lymphoid tissue. On February 18th, she reported her throat clear, but continued to have frontal headache. The temperature had remained normal during this time. The treatment given was external, consisting of applications of argyrol to the pharynx, heat to the sinuses, saline gargles, and nose drops of 1-percent ephedrine in saline solution. On February 21st she felt very ill, sneezing, coughing, and complaining of a sore throat. The temperature was slightly elevated to 99.8°F. She was referred to Dr. Phillip Sheridan, a nose and throat specialist, who reported congestion of the nose with considerable muco-pus, congested lymphoid islands in the throat, and sinuses clear but tender. His impression was that this was a case of influenzal rhinitis and pharyngitis. The patient was started on sulfadiazine therapy on February 25th, and this was continued for five days as follows: February 25th, 1.5 gm.; February 26th, 4 gm.; February 27th, 3 gm.; February 28th, 1½ gm.; March 1st, 1½ gm. She was discharged from the Infirmary March 4th feeling well. On April 15th she reported that her eyes had ached and twitched since her illness, but that she had been doing a great deal of studying to make up for time lost during her illness. She had consulted her home ophthalmologist, who prescribed lenses, but these gave her no relief.

Comment. Whether the sulfadiazine or the toxic effect of the upper respiratory infection was responsible for the impairment of the accommodative power cannot be determined with exactitude. It should be remembered that there was no appreciable rise in the patient's temperature during the attack and no other evidence of severity of infection. However, since the sulfa group of drugs does cause ocular disturbances such as optic neuritis, retinal hemorrhages, and conjunctival injection, we may surmise that disturbances of the accommodation may be caused also. Accordingly, we should keep in mind among the ocular manifestations of sulfa-drug toxicity the possibility of paresis of accommodation.

136 East Sixty-fourth Street.

SOCIETY PROCEEDINGS

EDITED BY DR. RALPH H. MILLER

COLORADO OPHTHALMOLOGICAL SOCIETY

November 15, 1941

DR. WILLIAM H. CRISP, *presiding*

JUVENILE CHORIORETINITIS

DR. GEORGE FILMER presented the case of E. H., aged nine years, who was found to have poor vision in the right eye when examined about one month previously. A brother, aged 13 years, was said to have poor vision in one eye, cause unknown. There was no other family history of blindness. The vision in the right eye sufficed only to count fingers at 6 inches. Examination revealed a large area of old pigmented chorioretinitis extending downward and slightly to the temporal side of the disc. About 3 disc diameters from the disc in the center of the area of chorioretinitis were several irregular, rounded, glistening, elevated areas with fingerlike projections on the surface over which the retinal vessels crossed. The tension was normal. Vision in the left eye was 20/20 and no pathologic change was observed.

DISCIFORM KERATITIS OF QUESTIONABLE ETIOLOGY

DR. B. W. MUIR presented the case of A.V., a Mexican youth, aged 20 years. The patient was sent to the hospital on September 4, 1941, complaining of photophobia of three days' duration. He had been told that there was a spot on the eye. The uncorrected vision was: O.D. 20/20−2; O.S. 20/30−1. The right eye was normal. The left eye showed slightly increased injection of the bulbar conjunctiva. Examination revealed a corneal lesion in the periphery at the 2-o'clock position which appeared like a disciform infiltration in the corneal stroma, about 2 by 2 mm. in diameter and coming in from the region of the periphery. Basically it appeared yellow, covered by many large and medium-sized blood vessels. These vessels did not extend beyond the inner margin of the lesion, but there was a corneal haze that spread fanwise from the lesion, diminishing as it extended about halfway across the entire cornea. No other lesions nor abnormalities were noted. What was seen of the iris appeared to be normal, and the pupil reacted to light. The extraocular muscles were normal and the tension was normal to palpation. The corneal surface was smooth, regular, and glistened throughout. Slitlamp examination revealed the anterior segment of the right eye to be normal; in the region of the lesion in the left eye the cornea was twice as thick as normal. The aqueous ray appeared negative. There was considerable striate wrinkling of the endothelial surface. The diagnosis was deferred. Syphilis and tuberculosis were considered, also acne rosacea, and many other types of disturbances which could have given this picture. The serologic test for syphilis was reported negative (Kahn); tuberculin test was 1-plus for the weaker solution. Blood count, urinalysis, blood sedimentation rate, X-ray studies of the sinuses and chest, and brucella agglutination tests were all negative. Applications of heat, atropine, and yellow-oxide massage were used. The patient was given typhoid vaccine intravenously, eight injections on alternate days. The opacity cleared considerably, and on November 21, 1941, the patient read 20/20 with the left eye. Slitlamp examination then showed vascularization

in the posterior stroma so suggestive of syphilis that another blood test was taken, which revealed a positive Kahn and a doubtful Wassermann reaction. Repeated tests since then have been more or less confusing. A spinal tap was done but up to this time the result had not been reported.

Traumatic rupture of the choroid

Dr. Harry W. Shankel presented the case of Mr. McD., aged 18 years, who was struck in the right eye by another's finger. The vision on the first examination was: O.D. 20/60; O.S. 20/30. External examination revealed swollen upper and lower lids of the right eye, ecchymosis of the lower lid, and a subconjunctival hemorrhage of the inferior lateral quadrant of the globe. The examination of the fundus through the undilated pupil showed no pathologic changes. The patient returned one week later complaining of distorted vision. Objects appeared narrower than normal. The external examination showed only slight subconjunctival hemorrhage remaining. The pupil of the right eye was dilated and revealed a choroidal tear surrounded by a hemorrhage inferior and temporal to the macula, with the hemorrhage involving the edge of the macula. The patient was seen again one week later at which time complaints were the same. The hemorrhage was organizing and assuming a glistening appearance. He was seen again 10 days later, and the vision was 20/40−2. The choroidal tear was unchanged but a horse-shoe-shaped exudate with the opening up surrounded the tear. The patient was seen two weeks later when he stated that vision was better but not perfect. The vision was 20/30+2 in the right eye, and 20/30 in the left eye. The tear remained the same but the exudate was absorbing, leaving a patch on each side of the tear with the connecting portion completely absorbed.

Angioid streaks

Dr. Henry S. Liebenberg presented the case, from the Colorado General Hospital Eye Clinic, of P. F., aged 40 years, who had scattered angioid streaks in irregular formation around the discs in each eye. The patient had been under antiluetic treatment, but there had been found no correlation between the angioid streaks and any systemic or general physical condition.

Superficial punctate keratitis

Dr. Henry S. Liebenberg presented the case of P. L., aged 34 years, who complained of burning, scratching, and tearing of his right eye ever since the eye was treated for ulcers eight months ago. Examination of the right eye showed multiple small corneal opacities in the lower half of the cornea involving Bowman's membrane and the superficial stroma, with elevation and thickening of the epithelium over the opacities. Several of the epithelial elevations stained with fluorescein. The tentative diagnosis was superficial punctate keratitis. The patient was treated with mixed vitamins; paliative and irritative ointments and solutions were used without result.

Low-pressure glaucoma

Dr. Henry S. Liebenberg reported the case of N. G., aged 63 years, who gave a history of decreasing vision during the past two years. The uncorrected vision was: O.D. 20/70, O.S. 6/200. The corrected vision was: O.D. 20/25, O.S. 6/200. The tension in each eye was 16 mm. Hg (Schiötz). Examination showed marked pallor and atrophy with some cupping of both discs. The retinal arteries were small. White spots, having a moth-eaten appearance, dotted the outer perimacular region in both eye. In the right eye there was marked contraction of the

peripheral field especially above with a suggestion of a nasal step. The left eye showed a very marked concentric contraction of the peripheral field. The blood and spinal-fluid aWssermann and the gold-curve test were negative. A tentative diagnosis of a possible low-pressure glaucoma, in which the optic nerve fibers have a low threshold to pressure and are destroyed more easily than normal, was made.

Malignant melanoma

Dr. Henry S. Liebenberg presented the case of L. L., aged 67 years, who gave a history of impaired vision and flashes of light in his right eye for four months. The uncorrected vision was: O.D. 12/200, O.S. 20/50. Examination with a dilated pupil revealed a large tumor mass extending into the vitreous past the midline from the nasal side of the globe. The mass looked brown on direct illumination and did not transilluminate. There was no evidence of metastasis elsewhere. The patient refused operative interference.

Dr. Liebenberg brought up the case of B. W., aged 59 years, who complained of gradual loss of vision in the right eye for over a year. The uncorrected vision was: O.D. 2/200, O.S. 20/100. The corrected vision was: O.D. 2/200, O.S. 20/20. Examination of the fundus of the right eye revealed a circumscribed grayish-brown retinal elevation of about 5 diopters and 5 to 6 disc diameters across in the inferior temporal quadrant beginning a short distance from the macula. In addition, there was marked retinal degeneration with whiter areas and pigment loss, and rearrangement present in the macular and perimacular region reflecting onto the superior portion of the area of elevation. The left eye had similar macular and perimacular areas of retinal degeneration, but no elevated masses. The mass in the right eye was too far posterior to be transilluminated. Diagnosis of malignant tumor could not be ruled out, but it was felt that the mass was probably not malignant. Subsequent examination showed that there had been regression of the elevation but an increase in the generalized retinal degeneration.

Acne-rosacea type of keratitis

Dr. Henry S. Liebenberg presented the case of L. P., aged 46 years, who complained of redness, tearing, and sensitiveness of the left eye to light for the past 20 years. The left eye had poor mobility and poor closure following operations at the age of 15 years for strabismus and ptosis. The patient had frequent treatments for exposure keratitis without success. Examination showed a superficial vascular area and opacity involving the superficial stroma at the 8-o'clock position and extending 5 mm. onto the cornea from the limbus. Because the corneal lesion had the appearance of an acne-rosacea type of keratitis a week of intensive vitamin-B-complex therapy was given in combination with oral riboflavin tablets. After two weeks there was decreased vascular injection of the corneal lesion and conjunctiva as well as decreased symptoms.

Vitreous prolapse

Dr. R. W. Danielson stated that it was his practice to stain all eyes with fluorescein and examine the wound with the biomicroscope for several days after a needling (especially of a membranous aftercataract), and that such routine practice would surprise many surgeons as to the number of areas where vitreous prolapse through the wound occurs but is not seen by ordinary gross examination. He reiterated the well-known fact that in a very high percentage of cases of needling, one will see with the slitlamp, a fine strand of vitreous passing through the aqueous and fastened to the corneal

wound for a long time after the needling. Theoretically, the round handle of the Zeigler knife is supposed to block the wound of entry to prevent loss of aqueous and to favor quick closure after the needling. Dr. Danielson stated that in his hands, however, he had been able to get a more thorough discission with a Wheeler knife because of the longer blade. In using a Wheeler knife one must be very careful, both in the puncture and during any sawing motion, to keep the dull side of the knife pressed against the wound as a fulcrum or one may get an embarrassingly large cut in the cornea. As illustrations of the fact that vitreous may prolapse through even a very small corneal wound, Dr. Danielson cited three cases in which it had occurred in his experience.

Harry W. Shankel,
Secretary.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

November 3, 1941

Dr. James W. Smith, *presiding*

The clinical interpretation of the vascular physiology of the retina

Dr. Walter F. Duggan stated that the normal arteriolar and capillary tone is regulated by epinephrine, acetylcholine, thyroxin, pituitrin, the sex hormones, vitamins, oxygen, carbon dioxide, histamine, various metabolites, the pH of the blood, and the meteorologic environment. An over or under supply of any of these factors may shift the reactions from the zone of physiology into the zone of pathology with resulting changes in form and function.

In the retina, spasm of the central retinal artery is a typical vasospastic lesion. It has been attributed to nicotine, adrenalin, ovarian insufficiency, lactation, cold air, syphilis, rheumatic fever, quinine, hypertension, toxemias of pregnancy, epilepsy, measles, and the removal of teeth. Some of these agents have been mentioned as the cause of acute retrobulbar optic neuritis and acute choroiditis. This same lesion can occur in the amblyopia following massive hemorrhage. Most of the patients who develop amblyopia following hemorrhage are ambulatory. An alkalosis due to the hyperpnea following exertion may be the precipitating factor in these cases. Most of the homeostatic reactions following hemorrhage can be attributed to epinephrine. Closure of the retinal artery in these cases is due to spasm, but this spasm is an exaggerated normal physiologic reaction. Closure of the retinal arteries has been associated with such diverse lesions as acute choroiditis, acute retrobulbar neuritis, Raynaud's disease, epilepsy, angina pectoris, apoplexy, hemianopias, encephalitis, and many other lesions. If individuals have multiple lesions, a basic etiologic process usually accounts for all of them. If spasm of the central retinal artery is a clinical entity, associated lesions could be due to vasospasm.

Many cases diagnosed as central angiospastic retinopathy are actually of choroidal origin. Choroidosis centralis serosa is such a lesion. This is comparable to an urticarial wheal under the retina at the macula and corresponds to Ricker's prestasis. In elderly patients, there may be a transudation of erythrocytes into the area of edema; the typical lesion of disciform degeneration of the macula results. Verhoeff has described the mechanism of its production.

A. L. Brown has pointed out that hyperemia of the disc and retina and even papilledema may follow the intravenous injection of diphtheria antitoxin. He believes that these transient lesions are of vascular origin.

Insulin, blood-sugar level, and epinephrine comprise one homeostatic equilibrium. In untreated diabetes, glucose is abundant but insulin is lacking; malnutrition of the retina may occur. When insulin is given and the blood sugar falls, insulin and glucose are both present, but, due to the homeostatic liberation of epinephrine, the retinal arteries may become so constricted that the blood cannot reach the tissues; localized capillary and tissue anoxia occurs. This may explain why a diabetic retinitis often does not improve when the patient is put into metabolic equilibrium as far as the urine and the blood sugar are concerned. Elwyn has noted that in diabetic retinitis varying degrees of prestasis, peristasis, and stasis are present, and that local circulatory disturbances account for retinitis. Changes occurring in normal eyes following insulin-shock therapy have been attributed (by Powell, Hyde, and Russell) to epinephrine that was "stimulated into action" by the insulin. Such an agent also explains the amblyopia due to massive hemorrhage. William Petersen has observed that meteorologic changes often precipitate acute ocular disease and that vascular spasm is the "modus operandi."

A physiologic approach to the interpretation and treatment of many ocular and extraocular lesions will be of benefit not only to the patient but also to the physician. The writings of Petersen, Felsen, Harkavy, Urbach, Taylor, and Dyrenforth Nedzel and Miles Atkinson along these lines deserve particular attention.

Discussion. Dr. Ferdinand L. P. Koch said that some of the nutritional and physiologic substances that appear to be of clinical importance in cell oxidation are the amino acids, epinephrine, glutathione, thiamine, and ascorbic acid. The latter, together with nicotinic acid and riboflavin, appears to be a factor in dehydrogenation; for example, phosphorylation of riboflavin, which occurs in the small intestine, results in the binding of the riboflavin to the specific protein with which it forms the flavin enzyme, the latter playing a role in oxygenation in the transportation of hydrogen. The optic neuritides, perhaps, might be considered, at least in the acute phases, as instances of altered local dehydrogenation.

It is not improbable that many of the local ocular catastrophies have their origin in oxygen want of either the stagnant or the histotoxic types. It is uncertain to what extent and for what reasons arteriolar spasm, primarily, and coincidental or secondary capillary constriction with the subsequent dilation of fatigue play a role in depriving the local vasculature and the local tissues of oxygen.

Constriction, or spasm of tissues capable of contractility, while probably developed as a protective reaction in primitive man, more often than not may be harmful to civilized man particularly when severe spasm occurs. There is a question, however, as Bryant and Fleming observed, whether, for example, the increasing vasoconstriction and hypertension are beneficial in eclampsia and in the toxemias of pregnancy because they tend to maintain adequate circulation, or if they are detrimental, since they are followed or accompanied by anoxemia, retention of waste products, edema, and even necrosis.

Benson and Boothby were able to measure an increase in the width of the blood column of the retinal arterioles and veins of subjects undergoing induced oxygen deprivation. As the latter was relieved and 100-percent oxygen was inhaled, these vessels, arterioles and veins, became but smoothly attenuated in caliber and the previous cyanosis was replaced by a rather marked redness of the entire fundus. The authors concluded that the

earlier dilation was a compensatory vascular reaction in order to supply the tissues with more oxygen and that this phenomenon was directly related to the degree of anoxemia. They further stated that, in spite of the reduction in caliber of the retinal vessels as the result of inhalation of 100-percent oxygen, the tissues locally were receiving not only an adequate but even an increased oxygen supply, and the reduced caliber would indicate a decreased blood flow suggesting that the retina possessed an autoregulatory mechanism for the control of its circulation as a protective reaction against a too-high concentration of oxygen. It was believed not improbable that similar effects took place in the cerebral circulation.

Generally, however, in spite of what is known of the aspects of cellular nutrition, our knowledge with regard to its clinical and therapeutic application would appear to be rather spottily faceted, since it seems unlikely that only one of several possible reactions or processes will occur at any given time in the normal course of events or in the production of deviations from that normal.

Dr. Benjamin Esterman asked if Dr. Duggan considered it advisable to use nicotinic acid for patients with a tendency to diabetic retinitis.

Dr. Duggan said he thought it should be helpful in early cases of diabetic retinitis. He had not had an opportunity to try it. He had used sodium nitrate in one case, and the vision improved from 20/100 to 20/30 in 18 days. Nicotinic acid has also been used only as a vasodilator with some success in various extraocular diseases.

A NEW INSTRUMENT FOR OPHTHALMODYNAMOMETRY

DR. ARTHUR LINKSZ read a paper on this subject which has been published in this Journal (1942, v. 25, p. 705).

Discussion. Dr. Koch said that those who worked with one or another of the many available ophthalmodynamometers will agree with Dr. Linksz as to the numerous clinical difficulties incidental to the determination of the retinal vascular blood pressures. He is to be congratulated on his ingenuity in modifying and redesigning the original Kukán apparatus in such a manner that simplification of handling and accuracy of readings have been attained.

The models designed by Bailliart have the advantage of being manipulated readily without the aid of an assistant. However, the majority of dynamometer readings are scaled in grams, usually of water, instead of millimeters of mercury. Other purely mechanical disadvantages of Bailliart's instruments, as well as those designed by several others, are so numerous that the published recorded measurements of retinal vascular pressures have come to be viewed with rather more scepticism than may be warranted.

Physiologically, it remains questionable whether the blood pressure in the retinal arteries is determined or if that in the ophthalmic artery is obtained. Ideally, it may be, as Duke-Elder maintains, that retinal arterial pressures may be ascertained only by means of inserting a micromanometer into a given vessel. Clinically, of course, this is an impossibility; primarily, we are concerned with the diagnostic information for therapeutic purposes that may be gained from ophthalmodynamometric studies. It is now established that there exists a mutual blood supply and a mutually regulatory mechanism for the circulation of the eye and the brain. Thus, among ophthalmodynamometric workers, there has arisen the concept of so-called isolated or solitary, cerebral or cephalic hypertension, with its counterpart of solitary retinal

hypertension, the clinical apprehension of which depends chiefly on the use of some of these instruments.

Bailliart, his co-workers, and followers, the great majority of whom have been enthusiastic proponents of ophthalmodynamometric studies to the minimization of other methods of examination, such as ophthalmoscopy, have been responsible for the development of a rather massive literature with regard to the diagnostic significance of this particular phase of retinal vascular dynamics.

At the present time, in many Latin-American countries, there not infrequently exists a tendency to employ the ophthalmodynamometer, chiefly the Bailliart instrument, rather more often than might appear to be indicated even for research purposes. In this connection, it appears that the conclusions reached by Lauber and Sobanski with regard at least to tabetic optic atrophy and its treatment as determined by the use of the ophthalmodynamometer are yet to be confirmed. It is most probable that the apparatus offered by Dr. Linksz will enable us to obtain data sufficiently accurate to permit the clarification of many of the current controversial problems in this field of clinical endeavor.

Dr. M. Davidson asked about the spontaneous venous pulse and the mechanism of the venous pulsation in pressure on the globe.

Dr. B. Fread asked whether the ophthalmodynamometer was of value in the determination of increased intracranial pressure.

Dr. Linksz stated that one finds spontaneous venous pulsation in about 50 percent of normal cases. Thus the intraocular pressure is not quite the same in systole and diastole. If, for example, the intraocular pressure is 20 mm. Hg in diastole, and 24 mm. Hg in systole, and the venous pressure is somewhere between 20 and 24, the venous pressure is higher than the intraocular pressure during diastole, whereas during systole the latter will be higher than the former. Thus the vein will be compressed with every systole. Of course, if the venous pressure is higher than the intraocular pressure during systole there will be no such spontaneous venous pulsation. In such a case, however, one has to raise the intraocular pressure by only a very small amount—for example, by a few millimeters—in order to elicit venous pulsation. With the Bailliart instrument this small increase cannot be measured. The vein always collapses during systole because it is in systole that the intraocular pressure becomes higher than the venous pressure.

As the vein leaves the optic nerve there is a second obstruction to the venous outflow in the sheath of the optic nerve. Here the pressure is identical with the intracranial pressure; namely, 110 to 130 mm. of water or 8 to 10 mm. Hg. The pressure on the central vein passing through the sheath of the optic nerve must therefore be at least 8 to 10 mm. Hg. Now, when, in the course of a pathologic process, the intracranial pressure should be increased to 30 mm. Hg, it exerts a compression upon the retinal vein as it passes through the sheath of the optic nerve, and the venous pressure is elevated to at least the same level. If, in this case, the intraocular pressure is 15 mm. Hg, one has to increase the latter by at least 15 mm. Hg in order to elicit venous pulsation. Of course, spontaneous venous pulsation cannot be present in such a case. This discrepancy between intraocular and retinal venous pressure is of great diagnostic value where increased intracranial pressure is suspected. Moreover, the retinal venous pressure is a rather accurate indicator of the intracranial pressure in such cases. On the

other hand, if spontaneous venous pulsation can be observed in a case of suspected increased intracranial pressure, the intracranial pressure cannot be higher than the intraocular pressure.

Entoptic manifestations of the retinal circulation

Dr. Benjamin Friedman stated that at each ventricular systole the column of blood within the arteries is driven forward, and at the same time a pulse wave is inaugurated along the entire arterial tree. The passage of both the retinal blood currents and the pulse waves is accessible to entoptic study.

The retinal currents are easily recognized in the movements of minute dancing bright spots which may be seen against the clear sky or in the field of the entoptoscope. They are best seen with filters of a wave length of about 400 millimicrons. Argument as to whether their origin lies in the red blood cells or in the white blood cells is not perfectly convincing either way, but it is certain that these spots are indicators of the current rate within the limits of their trajectories. These paths are in all probability the small retinal capillaries.

Through plotting these movements it is possible to delineate the vascular region of the retina. Pressure over the globe causes the corpuscles to slow down and then stop, but the intraocular pressure at this stopping point cannot be taken to indicate the normal pressure within the capillaries, for compression of the veins causes a simultaneous rise in the capillary pressure.

Scherer states that the normal corpuscular movement is pulsatile and that this pulsatory flow is unchanged in diseases which do not affect the retinal vessels. There is, however, a change from the pulsatile to a constant flow in the so-called "vaso-neurotic" cases, in retinal arteriolar sclerosis, in chronic retinal disease, and in glaucoma.

This view of capillary pulsations under normal conditions is contrary to our knowledge of capillaries elsewhere. The flow through capillaries is more or less a constant one, at least not pulsatile. Furthermore, if as in arteriosclerosis the tubular system approaches rigidity, it ought to approach the behavior of fluids in a rigid system of tubes, by an accentuation of the pulsatile flow.

The pulsatile part of the movement is very difficult to recognize, and it must be exceedingly difficult to train patients to make such critical observations. The pulsation appears simply as a change of pace along the corpuscles' path. This may be due to the irregular tortuous route of the capillaries; part of the path, when projected upon the layer of rods and cones behind, will seem shorter than it really is because of optical foreshortening. The rate of passage of a corpuscle along the foreshortened distance will appear considerably lower than in the adjacent parts.

Discussion. Dr. Koch reported that earlier workers, in attempting to evaluate the clinical significance of pulsatory entoptic phenomena, apparently failed to distinguish the separate identities of the expansion wave of the vessel wall and the pulsatory flow of blood within the vessel noted by Dr. Friedman. In his analysis of retinal vascular dynamics, in 1934, Dr. Jonas Friedenwald classified retinal arterial pulsations into serpentine, expansile, collapsing, and tonic. These terms were employed, however, with reference to ophthalmoscopic observations and no mention was made of the entoptic patterns these pulsations might produce. Conceivably the patterns might be of clinical value since the various types of pulsation normally and in diseased states are sufficiently gross to be observa-

ble ophthalmoscopically; however, their entoptic elicitation is not generally practicable in the absence of considerable intelligence on the part of the patient. Stationary defects such as lesions of the choroid and of the retina are observed more easily, of course, by means of autoophthalmoscopy.

Although there appears to be a reasonable explanation for the inability to visualize entoptically the choroidal circulation, how may one be certain, particularly if the entoptoscope is employed, that segments or areas of the choroidal circulation are not being visualized even transiently? Furthermore, when one is attempting to elicit these phenomena in the retina, it is hard to see how it is possible to distinguish between the pulsatory movements and the blood flow with regard to whether one is viewing vessels of capillary or precapillary size.

Dr. Friedman said that pulsations are seen only in the perimacular area. The macula is free from pulsations. If these were choroidal vessels they should give the same type of shadow in the macula. The choroidal structure in the macula is not different from the structure adjacent to it. The choroid consists of many superimposed layers and, this being the case, individual vascular patterns would not be seen. It is impossible to distinguish entoptically the structure of the capillaries. We can be made aware of them only through their blood "corpuscle" phenomena.

Dr. E. Krimsky asked why the blue filter was used for finding subjective circulatory phenomena and if any other filter could be used.

Dr. Friedman said that from experience it was found that the filters at the blue end of the spectrum gave better results. As the red is approached corpuscles become less distinct. It is impossible to see with red. He gave two possible explanations. 1. Red corpuscles absorb blue light and they become self luminous by internal reflection. 2. The blood vessels contain a chain of red corpuscles which absorb blue light and cast a shadow along the structure of the vessels. In between the corpuscles are leucocytes that are of a different color and that do not absorb blue light. We see these as bright white spots.

Sidney A. Fox,
Secretary.

COLLEGE OF PHYSICIANS OF PHILADELPHIA

Section on Ophthalmology

December 18, 1941

Francis Heed Adler, M.D., *chairman*

Macular and retinal degeneration of undetermined etiology

Dr. W. S. Reese presented a married woman, aged 25 years, on whom he had been unable to make a definite diagnosis. She was referred by Dr. Brasefield of Phillipsburg, New Jersey, who had seen her in December, 1938, at which time her fundi were negative and her vision was corrected to normal with relatively weak convex lenses. She returned the following May complaining of gradual loss of vision in both eyes, and, from Dr. Brasefield's description, there had evidently been little change in the picture since that time. Her vision was 20/200 in each eye, not corrected by lenses. Both discs were pale, with blurred edges, indicating a previous neuritis or possibly an active low-grade inflammation. Each macular region was dark and edematous looking, with several shiny points and a degenerative appearance. Throughout both fundi in the region of the posterior poles were a number of grayish-white lesions. These were beneath the retinal vessels, and were roundish with rather blurred edges.

The veins were dark, and the arteries possibly bright, although in general the vessels seemed fairly normal. The form fields were quite full; and no definite outlines of central scotomas had been obtained. All systemic and laboratory studies were negative.

This patient had been exhibited before the Ophthalmological Society in New York City by Dr. Brittain Payne, who wrote him that various opinions were held as to possible diagnoses. It seemed to him that the diagnosis lay between a postinflammatory condition and some degenerative affection, possibly an abiotrophy. It would seem to come under the latter classification.

Discussion. Dr. W. E. Fry commented that he had had the opportunity to see this patient on the previous afternoon. The fundus picture presented two conspicuous changes: (1) the changes that were widespread and appeared to him to have been of a diffuse colloid type; (2) the macular changes which, if they were dissociated from the widespread colloid changes, would remind one very much of the type of macular changes seen in the juvenile type of hereditary macular degeneration.

He had not seen the association of these two conditions in any other case. Whether that could occur or not he did not know. The ophthalmoscopic picture, in his mind, was chiefly that of a degenerative nature, involving the macula, and, in addition, showing the colloid changes of the lamina vitrea.

Dr. W. Zentmayer said he did not quite understand how one could have a macular degeneration with vision reduced to 20/200, and not be able to find a central scotoma. His own impression was that it was an optic-nerve condition, although he was on no safer grounds himself if he considered it to be a retrobulbar neuritis, as here also there should be a central scotoma.

He really did not study the fundus enough to pass on the nature of the diffuse changes. He took them to be hyaline, which was practically what Dr. Fry suggested.

Dr. M. H. Langdon remarked that he thought the macular changes were probably the source of the visual decline, and that the alterations in the head of the optic nerve were from an ascending degeneration. He was surprised that with a vision of 20/200 no central scotomas had been found. A thorough search should show a central scotoma on the Bjerrum screen, for he could not imagine a patient with a vision reduced to 20/200 and no scotomata discoverable on careful examination.

Bilateral thrombosis of the posterior calcarine arteries with sparing of macular vision

Dr. P. R. McDonald presented a case of bilateral hemianopia which he thought was caused by a bilateral thrombosis of both calcarine arteries. The patient had as his only complaint complete loss of peripheral vision. With correction, he was able to read 6/6 in both eyes, and Jaeger 1 without difficulty. Results of neurologic and medical examinations were essentially normal. The patient had first-, second-, and third-grade fusion, as tested on the synoptophore, and optokinetic nystagmus was readily elicited in all directions. The cortical representation of vision and the vascular supply to the area striata were discussed.

It was concluded that peripheral vision is not essential for stereopsis or spatial orientation, and that optic nystagmus may be elicited even if the field is reduced to about 2½ degrees, on either side of fixation. Apparently the performance of the

complex visual functions were dependent upon macular fixation and certain other associated pathways, which were not closely associated with the cortical areas supplying peripheral vision.

Discussion. Dr. W. I. Lillie stated that this was a rather unusual clinical case. He thought there was no question about the diagnosis, that it was vascular, because of the history of precipitous onset with two distinct episodes. He was sure they had all encountered cases in which bilateral blindness was present associated with intact pupillary reflexes, probably secondary to a toxic condition in which the entire visual cortex was involved. The visual loss was usually transitory. Dr. McDonald's diagnosis could be made very accurately by exclusion, because if the anterior and middle cerebral arteries were involved there would be contralateral motor and sensory disturbances. Fortunately, Dr. McDonald had not brought up the controversial point of sparing of the macula, as to whether there was a bilateral macular innervation.

The lantern slide showed the vascular supply of the cerebrum. The upper left-hand corner showed the middle cerebral artery, which supplies the lateral surface of the frontal, temporal, and occipital lobe. There was an overlapping of the posterior cerebral in a very small area.

It is known that the macular region is represented in the occipital pole, proved conclusively in cases of injury in the last World War by the appearance of homonymous scotomata when this region was involved. It was easy to imagine, in cases in which the macula was preserved in a bilateral thrombosis, that an anomalous branch from the middle cerebral to the pole of the occipital lobe gave added circulation (not unlike a cilioretinal artery). These very exceptional cases must have an anatomic explanation for the macular preservation. Lesions of the occipital lobe are negative neurologically.

Headaches or any signs of increased intracranial pressure in addition to a homonymous hemianopia and negative neurologic signs would be induced by a lesion in the occipital lobe.

Dr. M. H. Langdon said the type of bilateral accident which Dr. McDonald had analyzed and diagnosed was a most remarkable one. He thought he was very fortunate in having the condition come along at different times. It might have been rather confusing if those two thrombi had formed at the same time, and such things could happen.

Dr. F. H. Adler stated that cases of this kind were epoch making. These were the cases that made for progress in our knowledge of the physiology of the eye and an understanding of visual-field defects.

Most of them remembered that around 1910 there was a great discussion between Henschen and Willbrandt, on the one hand, who believed that there was an exact representation of the retinas in the visual cortex, and Von Monikow, who claimed that there was a diffuse representation of the retinas throughout the whole of the visual cortex. Von Monikow was so sure of his belief that he said in a more or less boastful way, he wished somebody would come along and shoot a central scotoma out of a brain for him. About four years later, with the advent of World War I, his request was granted.

During the war there were a large number of cases of occipital-lobe injuries in which the wounds were clean-cut and the patients lived long enough to be examined and have their visual fields recorded. Some of these patients subsequently died and complete sections of the brain were obtained. It was found that a central scotoma could actually be

shot out of a brain, if the injury were limited to the extreme posterior tip of the occipital lobe.

The case Dr. McDonald presented this evening showed several things. It demonstrated that the optomotor centers for the fixation reflexes were localized not only in the para- and peristriate region, as had been stated before, but also right over the striate area itself. In this patient an area of the posterior pole had been left intact, and was represented by a field some 5 degrees in extent laterally, and yet the individual had optokinetic nystagmus both to the left and to the right.

This was of more than academic interest. In the cases usually seen, in which right homonymous hemianopia is present, and the dividing line between seeing and blind areas went through the fixation point, reading was extremely difficult. On the other hand, patients with a left homonymous hemianopia that went right through the fixation point could read and did so with ease. It had been assumed that the reason for the difference in reading ability of these two types of patients was the fact that the patient with a right homonymous hemianopia had to search for the letters as he read from left to right, whereas the patient with left homonymous hemianopia was looking into the seeing halves of his fields, so to speak.

Dr. Adler would suggest that there was another reason for the difference between these two types of cases. Reading is accomplished by a series of involuntary movements on the part of the eyes, by means of which the eyes make five or six jumps across the page of ordinary print. In doing so, a number of letters are scanned at each jump. These reflex eye movements are brought about by stimuli of the optokinetic centers in the occipital lobe. If a patient had a right homonymous hemianopia, he got no stimulus from the blind fields for moving the eyes to the right, and hence there were no reflex movements of the eyes to the right. All movements now must be made voluntarily, and this was an awkward and a difficult way of reading.

The patient Dr. McDonald had presented this evening could read with ease, and this showed that it takes only a very small part of the right visual field to produce these reflex movements of fixation. This case demonstrated, therefore, that it takes only about 3 to 5 degrees of the central field to induce the movements of fixation necessary for reading. It was assumed formerly that these reflex movements were produced from the peri- and parastriate regions, which are well outside the fovea, and no one, as far as he was aware, had previously shown that the actual reflex could take place from the foveal cortex itself.

Dr. R. P. McDonald concluded by saying he would like to thank Dr. Lillie, Dr. Langdon, and Dr. Adler for their discussion. Unfortunately, the visual fields were not obtainable at the time of the first accident, and he presumed, he thought rightly, that the patient had a right homonymous hemianopia. He claimed that he could not see to the right with either eye, and that the eye was seen by Dr. Gardiner, who decided he had a homonymous hemianopia, although no visual fields were taken.

He thought any discussion of macular vision was not apropos in this case, as the fields did not prove one thing or the other. Dr. Langdon mentioned that he had stated this was the only case in the literature. This was the only case in the American literature; there had been several cases in the foreign literature.

Observations on the obstacle to squint training—amblyopia

This paper, presented by Dr. J. B.

FELDMAN and ANNABEL F. TAYLOR, R.N., was published in the May, 1942, issue of the Archives of Ophthalmology.

Discussion. Dr. P. J. Kennedy said he would like briefly to go over a few of the things which Dr. Feldman had brought out. First, the refractive error was no index of the degree of amblyopia. Secondly, the visual acuity would vary with the interest of the patient, the methods of examination, and the patience of the examiner. Those factors were also concerned when one measured the angle of squint. The interest of the patient and the patience of the examiner were extremely variable factors in the measurement of squint.

The question as to whether or not these patients had scotoma: They had two types of scotomas, with which they were here concerned, absolute and relative. If the target was large enough, none of these patients had an absolute scotoma. If the target was small enough—that is, if one used a 1 or 3 millimeter instead of a 9 or 11—they would have scotomas, and those were factors which should be taken into consideration in any statistics with regard to the presence or absence of scotoma in amblyopia.

Incidentally, the absence of constant simultaneous foveal perception could be demonstrated to anyone who would take the time to sit down in front of a synoptophore.

With regard to the state of development of amblyopia, they were all born blind, and vision developed. These amblyopic patients are seen in childhood, as a rule, or perhaps the squint does not become manifest until adult life; in the latter case the examiner is almost never able to obtain a record of normal vision before the patient presented himself. Therefore, the ophthalmologist is justified in assuming that the amblyopia then present is due to a lack of development of vision in that eye rather than a development of the amblyopia.

Dr. Feldman mentioned the Wollensack Allscope. Dr. Feldman used the Allscope as one of the methods of recording visual acuity, and he found that if the patient's vision was improved to normal by this telescopic lens, then by means of orthoptic training that patient's amblyopia could be brought up to practically normal, and the patient given simultaneous macular perception and fusion. If, on the other hand, there was no improvement by the use of the telescopic lens, orthoptic training was not exactly wasted, but there was very little visual improvement. There was a third group which came between those two groups, and in this there would be a degree of improvement by orthoptics that was commensurate with the degree of improvement in vision found by use of the telescopic lens in the routine examination.

It would be well for all to use the Allscope in their routine examination of amblyopic patients, in the hope of finding there a definite aid.

Dr. M. H. Langdon pointed out there was one thing he hoped Dr. Feldman would discuss and that was the relationship, if any, between the degree of amblyopia and the possibility of obtaining fusion. His own experience had been that if one eye had a vision of 5/25 or less it was very difficult to get fusion until one improved the patient's condition and lessened the amblyopia.

Whether one could improve the amblyopia or not could be discovered only by trying. There were cases in which possibly there had been some cerebral injury at birth, and no means could be found to improve the vision; even continuous occlusion of the other eye would not make that eye take up its normal function. The amblyopia is undoubtedly a great barrier to obtaining binocular vision

if it is of sufficient depth or magnitude.

One thing that Dr. Feldman brought out should be accentuated; namely, that if amblyopia has been overcome in an eye, the ophthalmologist must not assume that it has been achieved permanently. The child must be watched, because it may have a relapse. Dr. Langdon had one case in mind, which he observed in a child whom he had first seen when it was about three years old. The father had a convergent squint and a partially amblyopic eye. The older brother had been in a similar condition, and this child at the age of three years had a very definitely amblyopic eye. Dr. Langdon managed to test its visual acuity, which then was about 5/45, and this even increased to 5/6 by long occlusion. The child obtained good fusion. The squint disappeared. The child was then about 6½ years of age, and was to have been brought in for inspection, before the family went away for the summer, in June.

Dr. Langdon did not see the child again until the following February. The amblyopia had reappeared, for some reason or other, in spite of the fact that the squint had not increased. The fusion, while difficult to obtain, was still there, if one used a very dim illumination on the good eye to accentuate the image of the poor eye. But the amblyopia had gone back to 5/25, and vision could not again be improved.

Dr. Feldman had not stated the age at which amblyopia could be overcome. Presumably he had found, as most of them did, that in the younger children amblyopia could be overcome with much greater readiness than in older people. It was Dr. Langdon's experience that after the twelfth or thirteenth year, amblyopia was rather difficult to deal with. Up to the sixth or seventh year, he would say it was very amenable to persistent treatment in probably 95 percent of the cases. But, one had to have the coöperation of the parents. Many cases do not improve because of improper occlusion, the parents not grasping the necessity for this.

Dr. J. B. Feldman expressed his indebtedness to the discussers of his paper for their elucidation of the various factors which played a part in amblyopia. As Dr. Langdon had pointed out, the younger and more intelligent a child was, the better would be the results in amblyopic training, if such training were effective.

Warren S. Reese.
Secretary.

AMERICAN JOURNAL OF OPHTHALMOLOGY

Published Monthly by the Ophthalmic Publishing Company

EDITORIAL STAFF

DERRICK VAIL, LT.-COL. (MC), A.U.S., *Editor-in-Chief* (on active duty)

LAWRENCE T. POST, *Acting Editor-in-Chief*
640 South Kingshighway, Saint Louis

WILLIAM H. CRISP, *Consulting Editor*
530 Metropolitan Building, Denver

WILLIAM L. BENEDICT
The Mayo Clinic, Rochester, Minnesota

FREDERICK C. CORDES
384 Post Street, San Francisco

RALPH H. MILLER
803 Carew Tower, Cincinnati

C. S. O'BRIEN
The State University of Iowa, College of Medicine, Iowa City

ALGERNON B. REESE
73 East Seventy-first Street, New York

M. URIBE TRONCOSO
500 West End Avenue, New York

F. E. WOODRUFF
824 Metropolitan Building, Saint Louis

ALAN C. WOODS
Wilmer Ophthalmological Institute, Baltimore

EMMA S. BUSS, *Manuscript Editor*
5428 Delmar Boulevard, Saint Louis

Directors: LAWRENCE T. POST, President; WILLIAM L. BENEDICT, Vice-President; DONALD J. LYLE, Secretary and Treasurer; WILLIAM H. CRISP, HARRY S. GRADLE.

Address original papers, other scientific communications including correspondence, also books for review and reports of society proceedings to *Dr. Lawrence T. Post, 640 South Kingshighway, Saint Louis, Missouri.*

Exchange copies of medical journals should be sent to *Dr. William H. Crisp, 530 Metropolitan Building, Denver, Colorado.*

Subscriptions, applications for single copies, notices of change of address, and communications with reference to advertising should be addressed to the *Manager of Subscriptions and Advertising, 837 Carew Tower, Cincinnati, Ohio.* Copy of advertisements must be sent to the manager by the fifteenth of the month preceding its appearance.

Author's proofs should be corrected and returned within forty-eight hours to the *Manuscript Editor, Miss Emma S. Buss, 5428 Delmar Boulevard, Saint Louis, Missouri.* Twenty-five reprints of each article will be supplied to the author without charge. Additional reprints may be obtained from the printer, the George Banta Publishing Company, 450-458 Ahnaip Street, Menasha, Wisconsin, if ordered at the time proofs are returned. But reprints to contain colored plates must be ordered when the article is accepted.

GRADUATE STUDY DURING THE WAR

"If there ever is a time when we should do our best work and maintain the highest standards it is now." This statement is from the preface of the program of the Twelfth Annual Mid-Winter Course on Ophthalmology and Otolaryngology of the Research Study Club of Los Angeles, which was held January 18th to 29th. That many agree with this is evidenced by the fact that the enrollment was the largest ever recorded in this course. The roster represented many states and included the Territory of Hawaii, and Canada. The serious attention of the men attending further indicated that the practitioner feels the need for all possible aid during these trying times and realizes his additional responsibility now that so many physicians are with the armed services.

Just preceding the course the American Board of Ophthalmology held an examination at the Los Angeles General Hospital, on January 15th to 17th. More than 60 candidates were examined, many of them in the armed forces.

The program of the Mid-Winter Course was an Edward Jackson Memorial Program. Dr. Jackson, who inspired the three-day courses of the American Academy of Ophthalmology and Otolaryngology, gave further evidence of his

interest in postgraduate training by being a regular attendant and instructor at Los Angeles. In his editorial comments on the course he always stressed the "need for a physician to continue to study so long as he continues to practice." His absence was keenly felt by all who had previously attended.

This year the teaching staff included many well-known instructors. The lectures given were of a practical nature and covered a variety of subjects rather than being limited to a large series of lectures on some one phase of ophthalmology.

Dr. Conrad Berens of New York discussed some of the preferred techniques and operative results in eye surgery.

The discussion of sympathetic ophthalmia by Dr. Georgiana Dvorak-Theobald of Oak Park, Illinois, was a classic presentation of the subject in a manner that made for a very much better clinical understanding of the disease. Excellent lantern slides were used to demonstrate the histologic pathology of the disease.

The diagnosis and surgery of orbital tumors was discussed by Dr. William L. Benedict of the Mayo Clinic. The various surgical procedures indicated were illustrated by excellent motion pictures.

Dr. Sylvester Judd Beach of Portland, Maine, gave two lectures on refraction, discussing recent developments in noncycloplegic refraction and the use and abuse of cycloplegia. He also presented his method of measuring astigmatic errors.

Dr. Otto Barkan of San Francisco, who has done so much original work on gonioscopy and glaucoma, devoted four one-hour periods to a discussion of angle changes as related to glaucoma. During the instruction-course hour he demonstrated gonioscopy to small groups, using patients suffering from glaucoma.

The important subjects of malingering and color sense were covered by Dr. George Hosford of San Francisco in an instruction course in which the methods of testing for malingering were demonstrated.

Dr. Frederick C. Cordes of San Francisco discussed the newer concepts of acute fundus pathology and its treatment with vasodilators.

One afternoon was devoted to war ophthalmology, in which this speaker covered the nonsurgical care of war injuries, and Dr. Meyer Wiener of Saint Louis and Coronado discussed the surgical care of these cases, based on his personal experience in the last war. Because of his position as Consultant in Ophthalmology to the Naval Hospital at San Diego, Dr. Wiener was also able to present some important points in the treatment of these cases as based on experience in the South Pacific. It is of interest that among the intraocular-foreign-body casualties there has not been a single case of a magnetic foreign body.

Irving B. Lueck, M.S., took up the analysis of various optical problems relative to anisometropia, presbyopia, aphakia, spectacle reflections, colored lenses, and the standardization of visual-acuity measurement.

Dr. Chauncey D. Leake, newly appointed Vice-President and Dean of the University of Texas Medical School, discussed the general principles of pharmacology as related to the eye, ear, nose, and throat. Dr. Leake, who is one of the best-known teachers in his field of pharmacology, gave three one-hour lectures on the subject.

The round-table luncheons devoted to answering questions asked by men attending the course were held daily and were found to be both interesting and instructive.

These Mid-Winter Courses have al-

ways been well attended by the men from the Pacific Coast, with an additional fair percentage from other parts of the country. The fact that the out-of-state percentage this year was just as large or larger is significant. In many instances men came great distances, in one case from Hawaii and in another from Canada. These journeys were made in spite of the annoyances, delays, and discomfort of present-day travel. The serious attitude and attentiveness of the men during the course indicated very clearly their earnest desire to acquire as much knowledge as possible. The large enrollment seems to answer those individuals who believe that scientific meetings should be discontinued because of the war. It would also seem to confirm the opinion of some of the leaders of ophthalmology that graduate study during war time is important and should be continued.

Frederick C. Cordes.

THE FUTURE OF ANISEIKONIA

Any therapy that depends primarily on subjective elements for proof of its efficacy must travel a long and hard road. It was easy to convince physicians and laymen that lenses that improved vision, such as those for myopia and presbyopia, were valuable, but it required several centuries more for the realization that they might help headaches, eyestrain, abdominal complaints, and even a crotchety disposition. How could it be that the correction of only 1 or 2 diopters of hypermetropia, for example, might bring comfort to a person with 10 or 12 diopters' amplitude of accommodation, especially if the next person in a similar situation was not helped by such correction and the next had no symptoms from a similar condition? However, time and experience proved such to be the case. It is to be hoped that a century will not be needed to evaluate aniseikonia.

The situations are unfortunately comparable. In aniseikonia we have a condition known to be present in certain cases, but the question is, does it cause discomfort? There seems no sure way to get objective proof. Possibly some tests such as the rate of blinking, heart-beat rate, and blood-pressure changes observed with and without eikonic correction might prove of objective value, but objection would certainly be made by those who consider these tests as unreliable criteria on reading comfort. At present apparently the estimation as to help obtained from aniseikonic correction must depend on the opinions of the individuals who have worn these lenses. If there were a sufficient number of disinterested reports available, this might be determinative. If this statement is correct, and let us for the moment so assume, the natural question follows, why after 10 years have only a few ophthalmologists been convinced one way or another on this subject? Again supposition is assumed, but from the writer's contact with ophthalmologists from all sections of the country for the period of his own keen interest in the subject, he has no doubt that few oculists have made up their minds about the value of aniseikonia. In fact, this subject is often dismissed with a smile that seems to imply that those who are convinced that there is some virtue in eikonic glasses are slightly "teched in the head."

Reverting to the statement that proof of the value of aniseikonia would rest in sufficient disinterested clinical evidence, why has this not been forthcoming? Partly because in an effort to control the early clinical studies properly, only a small number of instruments were manufactured and placed in a few selected institutions, so only a relatively

small total number of examinations were made, whereas tests of very many patients were needed for convincing proof. Secondly, most of the examinations and prescriptions have emanated from the originators of the test, and as it is well known that parents love their own children and often are overenthusiastic about them, whether true in this case or not, at least this possibility is realized by those attempting to weigh the evidence for and against aniseikonic lenses.

What are the doctor's probable reactions on this subject? Given a test in the field of the very special practice that he himself cannot make routinely on his patients, or that he cannot even have some one else make on most of his patients, how is he going to feel about it? Naturally, he will tend to entertain a secret or even open animosity, and a ready willingness to welcome any report of its uselessness. What kind of patient does he refer to aniseikonic clinics? Obviously only those whom he has failed to relieve with the usual lenses and these are those who, in general, because of nervous instability, are bothered by ocular as well as other trivialities and often have exhausted his patience. Thus the aniseikonic clinics have become the rendezvous of the most difficult patients for whom to obtain comfort. That *anything* good is accomplished for these patients is the miracle. Another factor is a disinclination of the home ophthalmologist to refer patients for eye examinations to other centers; he may feel that this in itself is a reflection on his own ability and his equipment. Furthermore, he may resent the fact that the opportunity to test and prescribe for this condition was not made available to all ophthalmologists at the same time.

The value of aniseikonia may, to be sure, finally become known under the present working plan, but it will require much time and the truth will be delayed far longer than necessary.

In brief, the need is to make the test available to all and to broaden the base for the filling of prescriptions. This means a simplified test instrument at a lower price, and would imply a quicker and easier technique. To this must be added a very great reduction in the cost of the finished lenses. No implication that the exceedingly high costs now prevalent are unnecessary is intended, but the fact remains that under present conditions the average ophthalmologist can afford neither the time to make the examination nor the expense of the equipment, and the average patient cannot afford the lenses. Until these matters can be changed there is no hope for a true evaluation of aniseikonia.

Lawrence T. Post.

X RAY IN MEASUREMENT OF LENGTH AND REFRACTION OF EYE

Proper understanding of the principles, and skill in the measurement, of ocular refraction demand a certain capacity for mathematical concepts. The average ophthalmologist is satisfied by a mere nodding acquaintance with the finer mathematics of the subject, and is rather easily scared by such elaboration of mathematical explanation as is to be found in the works of Helmholtz and Gullstrand. Yet, if only as a matter of intellectual stimulation, it might be better for all of us occasionally to devote time and energy to a realization of what the pioneers in optical mathematics have accomplished and what others are still achieving.

Earlier estimations of the total refractive power of the living eye were extremely complicated. It was necessary to

determine the refraction of the cornea, and the position and refraction of the anterior and posterior surfaces of the lens. The refractive index of the lens was not accessible to exact calculation, and satisfactory and easy measurement was possible only as regards the cornea.

Recently Schoute and Colenbrander (Ophthalmologica, 1940, volume 99, page 282 and page 402, respectively) developed a method for estimating the total refractive power of the eye from its chromatic aberration, the means of calculation including the difference between the refractive power of the lens for monochromatic red and blue light, the refraction of the cornea, and the length of the eyeball. The length of the eye was thus measurable within 0.18 mm.

By a technique which is fascinating in its ingenuity, Goldmann and Hagen of Bern, Switzerland (Ophthalmologica, 1942, volume 104, page 15), now show the possibility of utilizing X rays for measurement of the total refraction of the living human eye. The process is one for the scientific laboratory and does not add to the armamentarium of the practicing ophthalmologist. But an even fuller explanation of the process than is afforded by Haessler's excellent abstract (page 222 of the February, 1943, issue of the American Journal of Ophthalmology) may appeal to the more scientifically minded among our readers.

Goldmann and Hagen make use of the fact that roentgen rays are perceptible to the dark-adapted eye, and in measuring the length of the eyeball they have employed an improvement of the technique advised by Rushton (Transactions Ophthalmological Society of the United Kingdom, 1938, part 1, page 136), which depends upon the same fact of limited visibility of the X ray.

All the measurements involved are rendered possible by the further fact that, whereas the course of light waves is altered in varying degrees by the different ocular media and their surfaces, the X ray passes in a straight line through such media and surfaces; in other words, it does not undergo refraction.

The measurements are made in a dark room, after the eyes of examiner and subject have undergone adaptation to darkness. A red spot of light on the opposite wall is used as a fixation point. Two narrow parallel bundles of roentgen rays are allowed to pass through the eye under observation, and are perceived by the subject as vertical lines on the wall, in a definite relation to the fixation point. From two projectors, two fine parallel lines of white light are projected on the wall in the vicinity of the red fixation point. By means of a rack-and-pinion adjustment, the test person varies the distance between the two lines of light until their positions appear to coincide with the positions of the two roentgen lines. The person under examination must maintain steady fixation of the red fixation-point while using slightly indirect vision for adjustment of the relationship between the roentgen lines and the projected lines of light.

Among other factors, provision must naturally be made for exact information concerning the distance between the apex of the cornea and the fixation point.

When the apparent position of the roentgen lines upon the wall coincides with the actual position of the projected lines of light, the dimensional relationship between the lines of light and the roentgen lines becomes that of object and retinal image, since the unfocused roentgen lines are falling upon the retina in the same positions as the bundles from the focused lines of light. If the length of the eye is known, the examiner possesses all the necessary data for measuring the total refraction of the eye, in accordance with

formulae which are given in the essay.

For measuring the length of the eyeball, use is made of a roentgen tube from which a linear bundle of rays passes through a slide in an adjustable diaphragm, to intersect the anteroposterior axis of the eyeball at right angles.

In this procedure, the bundle of X rays is perceived by the eye as a ring whose diameter diminishes in size as the retinal region intersected by the rays comes nearer to the posterior pole of the eye. When the X-ray beam falls tangent to the retina, at the posterior pole, the eye sees only a spot which disappears upon further movement of the apparatus in the same direction. The length of the eyeball is the distance between the recorded position of the apex of the cornea and the position at which the tangent X-ray beam ceases to stimulate the retina. The optical contrivance by means of which the position of the corneal apex is observed and recorded, in darkroom conditions, is described and illustrated in Goldmann and Hagen's paper.

At least ten measurements were made on each subject. The total dose of X rays received by the eye was always far below the level at which risk of injury to the eye could be anticipated. The results showed an average margin of error of less than one percent, and were in substantial agreement with those published by Gullstrand and other writers.

W. H. Crisp.

BOOK NOTICE

MEMOIRS OF A GUINEA PIG, 8 YEARS SPENT IN A DOCTOR'S WAITING ROOM. By Howard Vincent O'Brien. Illustrations by Robert Mills, 238 pages. New York, G. B. Putnam & Sons, 1942.

"Would the guid God the giftie gi'e us
To see oursel's as ithers see us."

Herein lies the opportunity to fulfill the thought of the poet. It may require a little courage for the doctor to encounter the reactions of a layman who has had an eight-year unsuccessful experience with doctors, endeavoring to discover the cause of his continually increasing scotomata. The physician, at any rate, will be tickled with the pungent humor that serves as a pleasing antidote to the penetrating barbs of the astute author.

Much truth is slipped in between the funny anecdotes. For example, he writes: "For purpose of diagnosis there will be an increasing variety of ingeniously effective machines. But for the interpretation of this diagnostic material, there must always be the fallible human mind. And for that ultimate, mysterious harmony of causes that makes sick men well, there must be an intimately personal relationship—a singularly indefinable compound of art, science,—*and* affection."

For a good chuckle and a pleasant two hours' reading I recommend this book. If the subject matter alone did not lure one, the brilliant illustrations of Robert Mills would be reason enough for owning the book.

Lawrence T. Post.

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

7

UVEAL TRACT, SYMPATHETIC DISEASE, AND AQUEOUS HUMOR

Greene, H. S. N. **The participation of the anterior chamber of the eye in resistance phenomena related to tumor growth.** Cancer Research, 1942, v. 2, Oct., p. 669.

The ease with which tumors and other living tissues can be transplanted by using the anterior chamber of the eye for inoculation has given rise to consideration of the reasons for the increased susceptibility of the chamber as compared with other bodily regions. It has been found by experiment that there is a low concentration of antibodies in the aqueous humor of immunized animals, and there has been speculation as to whether a barrier might exist between the blood and aqueous. Some investigators have reported inability to transplant the Brown-Pearce tumor in the anterior chamber of rabbits "immunized" to that tumor. Other workers have recently reported that growth occurred in the anterior chamber after a latent period, whereas other tissues resisted transplantation.

The authors, utilizing several standardized tumors of various derivations and rates of growth, repeated the experiments and found that, following tumor growth in the anterior chamber, both the testicle and the anterior chamber of the opposite side were resistant to reinoculation. The conclusion appears justified, therefore, that the aqueous humor is not an independent, isolated fluid but, on the other hand, participates in general bodily reactions, at least as far as tumor resistance is concerned. It was further concluded that the resistance-provoking powers of the tumors used were directly related to their longevity and rates of growth. The ability of the various tumors to grow in partially resistant hosts appeared, however, to be a function of their stromal requirements. (8 references.) Ralph W. Danielson.

Hansen, E. W. **Mechanism of uveitis.** Minnesota Med. Jour., 1942, v. 25, June, p. 455.

The marked clinical similarity in cases of uveitis where the etiologic factors are widely divergent raises the

question as to how infection with syphilis, tuberculosis, or gonorrhea, or from isolated foci in teeth, tonsils, prostate, or cervix brings about inflammation of uveal tissue. Direct invasion of the blood stream by organisms or filterable viruses accounts for the development of syphilitic or tuberculous nodules and for free pus formation in septicemia. The toxins dirived from micro-organisms may also invade the blood stream. Probably the most important means of invasion is by sensitization of uveal tissue to various allergens. Edna M. Reynolds.

Woods, A. C. **Focal infection.** Amer. Jour. Ophth., 1942, v. 25, Dec., pp. 1423-1444. (7 tables, 3-page bibliography.)

8

GLAUCOMA AND OCULAR TENSION

Dayal, Sukh. **Etiology of glaucoma, its various methods of treatment and their merits.** Indian Med. Gaz., 1942, v. 4, April, p. 233.

It is argued that glaucoma is a symptom complex of vascular origin rather than an increase in intraocular tension due to obliteration of the filtration angle. The action of eserine is by stimulation of the parasympathetic system, not by contraction of the pupil. The occurrence of high blood pressure in glaucoma is accidental and not essential. In the treatment of acute glaucoma, the combined action of doryl and eserine locally is recommended, as well as the use of doryl intramuscularly. Trapdoor iridectomy is advised in cases where the anterior chamber is very shallow. Glaucosan massage is recommended instead of instillations.

Chronic glaucoma is also attributed to defective circulation. Advantages of iridencleisis over corneoscleral trephining are discussed, and the techniques of iridencleisis, of the Lagrange operation, and of cyclodialysis are outlined. Edna M. Reynolds.

Kull, Jenny. **The use of prostigmin in the treatment of glaucoma.** Ophthalmologica, 1942, v. 104, July, pp. 23-31.

Prostigmin, like eserine, causes in rabbit eyes a transitory initial rise in intraocular tension which is followed by a decrease in tension. In patients with glaucoma its use is followed by decrease in tension. Occasionally this follows even when there has been no response to pilocarpine. The drug is most effective in chronic simple glaucoma. It is usually employed in from 1- to 3-percent solution, rarely 5-percent. In general, the 3-percent solution is well tolerated, whereas a 5-percent solution is occasionally irritating. The conclusions are based on tonometric measurements on the eyes of rabbits and of 31 patients. F. Herbert Haessler.

Montalván, Plinio. **Prostigmine in the treatment of glaucoma: its effect on intraocular pressure.** Amer. Jour. Ophth., 1943, v. 26, Jan., pp. 57-62. (5 tables, references.)

Payne, B. F. **Evaluation of glaucoma operations.** Amer. Jour. Ophth., 1942, v. 25, Dec., pp. 1474-1481; also Trans. Amer. Acad. Ophth. and Otolaryng., 1942, 46th mtg., July-Aug., p. 279. (9 figures.)

Sugar, H. S. **Place of hemorrhagic glaucoma in etiologic classification of glaucoma.** Arch. of Ophth., 1942, v. 28, Oct., pp. 587-598.

Hemorrhagic glaucoma is a disease entity that occurs in occlusion of the central retinal vein and in diabetic rubeosis iridis, and perhaps follows massive retinal hemorrhage and hemor-

rhage into the vitreous. In these conditions the glaucoma results from inflammatory changes associated with the disintegration and absorption of intraocular hemorrhages. Hemorrhagic glaucoma differs clinically from simple glaucoma in its malignant onset with vascular congestion, and from true acute glaucoma in that the anterior chamber is of normal depth rather than shallow. Hemorrhagic glaucoma does not occur in venous occlusion unless the entire central vein is blocked. It has not been observed in occlusion of the tributary veins. Sugar reports nine cases of glaucoma following venous occlusion. Simple glaucoma may be found in the fellow eye in such cases. This is an indication of the vascular sclerosis which is probably the common background for both conditions. Three cases of the comparatively rare glaucoma associated with diabetic rubeosis iridis are reported. This, like other hemorrhagic glaucoma, is characterized by new-formed blood vessels on the iris surface and in the chamber angle, closing the latter. (2 tables, 6 charts, references.) John C. Long.

Weekers, L., and Weekers, R. **Mode of action of antiglaucomatous operations, particularly diathermy of the ciliary body.** Ophthalmologica, 1942, v. 104, July, pp. 1-14.

All surgical procedures devised for the control of ocular hypertension are forms of trauma which cause temporary or permanent changes in the intraocular circulation of the blood. A new equilibrium between blood and aqueous is brought about and this results in decreased tension. The trauma involves the anterior uvea, which is the seat of production and resorption of aqueous. Diathermy of the ciliary body is no exception to this general principle. It is, however, the least destructive procedure, with a minimum of operative trauma and a maximum of influence on uveal circulation.

Anatomic studies of many animal eyes and two human eyes show that whatever the method of using diathermy—surface application or microperforation—the reduction of tension which has been disclosed by clinical measurement results from an enormous blood-vascular dilatation in the uvea. (4 figures, references.)

F. Herbert Haessler.

9

CRYSTALLINE LENS

Salit, P. W., Swan, K. C., and Paul, W. D. **Changes in mineral composition of rat lenses with galactose cataract.** Amer. Jour. Ophth., 1942, v. 25, Dec., pp., 1482-1486. (3 tables, bibliography.)

10

RETINA AND VITREOUS

Anderson, G. E. **Problem of retinitis in the diabetic patient.** Arch. of Ophth., 1942, v. 28, Oct., pp. 679-690.

Diabetic retinitis is essentially a vascular disease, a part of the generalized arteriosclerosis common to diabetics who have had the disease eight years or longer. The duration of the diabetic state determines the onset of arteriosclerosis more than does the age of the patient. Present-day diabetic treatment is not adequate to prevent the development of generalized arteriosclerosis and retinitis. It is assumed that abnormal metabolism of fats plays an important part in vascular decay. The author discusses in considerable detail the utilization of fats in diabetics. Lipocaic, a pancreatic extract, prevents the accumulation of fat in the liver in experimental animals and probably also

in human diabetics. Whether its administration will retard the development of arteriosclerosis is undetermined. While at present it may not be possible to prevent the ultimate development of arteriosclerosis, it may be possible to delay its appearance and to forestall some of the vascular accidents accompanying it. Three factors are of importance in the modern control of diabetes. First, an adequate carbohydrate diet must be given to prevent the mobilization of fats. Only the minimum of fat necessary for weight maintenance is prescribed. Secondly, an adequate or liberal diet of protein is allowed, as it protects the liver from fatty degeneration. Thirdly, the blood sugar should be kept at its optimal level. There is no evidence that endarteritis is improved by keeping the blood sugar at so-called normal levels. Arteriosclerotics do not do well with hypoglycemia. Apparently the optimal level of the blood sugar is higher than the orthodox standard provided that there is no change in weight and no persistent glycosuria. Insulin is to be administered as needed to maintain this balance. Suggestions are made for the management of the diabetic to retard development of arteriosclerosis and, if arteriosclerosis has already developed, to prevent needless vascular accidents. (2 illustrations, references.)

John C. Long.

Argañaraz, Raul. **Detachment of the retina.** La Semana Med., 1942, v. 49, July 16, pp. 124-132. (See Amer. Jour. Ophth., 1943, v. 26, Jan., p. 102.)

Castroviejo, R. **Adjustable retractor for retinal detachment.** Trans. Amer. Acad. Ophth. and Otolaryng., 1942, Jan.-Feb., p. 137.

This retractor is similar to Arruga's speculum, but the spread of the blades may be regulated by a screw affording exposure of operative fields of varying size. (2 figures.) George H. Stine.

Cooper, E. L. **Angioid streaks in the retina.** Michigan State Med. Jour., 1942, v. 41, July, p. 563.

A case of angioid streaks in the retina with macular change in one eye is reported. The patient had bronchiectasis of eight years duration. It is suggested that, since bronchiectasis may be associated with degeneration of elastic tissue in the bronchioles, every case of bronchiectasis should have a fundus examination to determine the frequency of association of this condition with angioid streaks in the retina.

Edna M. Reynolds.

Garabédian, M. D., and Meunier, P. **Adaptometry.** Ophthalmologica, 1942, v. 104, Aug., pp. 65-85. (See Section 1, General methods of diagnosis.)

Gonçalves, Paiva. **Perforating lesions of the macula.** Arquivos Brasileiros de Oftalmologia, 1942, v. 5, Feb., pp. 4-9.

Two cases are described. In the first the patient, aged 46 years, noticed sudden loss of vision upon sneezing. The eye had shown a hemorrhage in the macula upon the occasion of a first examination by another ophthalmologist. But there was a typical "hole" at the time of Gonçalves' examination. The second patient, 21 years old, had a number of foci of old chorioretinitis. At the macula, but occupying an area larger than the optic disc, was a circular area in which retinal tissue was absent. In closing, the author asks why these two retinal holes were not accompanied by detachment of the retina. (One illustration.)

W. H. Crisp.

Heiman, Marcel. **Riboflavine.** Arch. of Ophth., 1942, v. 28, Sept., pp. 493-502.

Various observers have shown that there is a considerable amount of riboflavin in the retina. Apparently a reduction in this riboflavin produces dimness of vision, especially in weak illumination, and also causes photophobia. The visual symptoms quickly disappear when riboflavine is administered. Heiman, using photographic printing paper, demonstrated that riboflavine had a protective effect on the photosensitive substance. Riboflavine has the ability to form an oxidation-reduction system upon which is perhaps based its power as conveyor of the physiologic stimulus. It is the only conveyor substance in the fovea centralis. The fluorescent property of riboflavine may transform light of short wave-length into light of maximum activity. The photodynamic effect of the vitamin may intensify weak and insufficient light, especially in the short waves of the spectrum. It may also protect the cones from the effect of excessive light. It is thought that riboflavine affects the visual act only in so far as the cones are concerned. Riboflavine and carotine have various similar characteristics and may be engaged in the same functional processes. (References.)

John C. Long.

Livingston, P. C. **Studies in night vision and night visual judgment as it concerns the ophthalmology of flying.** Irish Jour. Med. Science, 1942, June, p. 177. (See Section 3, Physiologic optics, refraction, and color vision.)

Mattos, W. B., and Camargo, A. **Retinal detachment due to retinal cyst.** Arquivos Brasileiros de Oft., 1942, v. 5, Feb., pp. 1-4.

A man of 34 years had bilateral retinal detachment, which had been under observation for eight months. Operation had been postponed because the detachment was atypical and the prognosis doubtful. In the right eye there was a typical retinal cyst downward and outward, and in the left eye a similar cyst upward and inward. The cysts hardly showed any retinal tissue, were transparent, and could only be diagnosed by the position of the retinal vessels and by a limiting shadow produced by movements of the ophthalmoscope. Both retinas had so-called cystic degeneration, showing small white formations sometimes arranged like bunches of grapes, sometimes like glove fingers standing out from the retina (as described by Anderson in his book on detachment of the retina). Apart from these degenerative changes it was impossible to discover retinal perforation or disinsertion. In each eye the retina was detached from the choroid at various points. All the retinal vessels were tortuous and there were retinal striae, few in number in the right eye but more numerous in the left eye. The cyst in the right eye was a good deal larger than that in the left eye, and in each eye it was impossible to examine the cyst with the ophthalmoscope throughout its full extent, because its outlines were lost in the ora serrata. The discs were moderately atrophic. The left eye showed several ruptures of the choroid.

An operation was performed on the right eye, the cyst being punctured with the diathermy needle, and several additional perforating diathermy punctures being made. The vision of this eye improved from counting fingers at five meters to corrected vision of 0.2, and later improvement is recorded to the extent that the patient "could read

quite easily." The patient declined operation on the left eye. (2 illustrations.)

W. H. Crisp.

Mitchell, David. **Sarcoid of Boeck.** Irish Jour. Med. Science, 1942, June, p. 204.

Mitchell reports a typical case of Boeck's sarcoid with involvement of the skin and bones of the hands. Localization of an eye lesion in the retina rather than in the uvea is unusual. The patient had a paracentral scotoma arising from several grayish masses overlying the retinal vessels along the temporal border of the disc. After six months these nodules had coalesced into several yellowish-white plaques, with progressive loss of vision.

T. E. Sanders.

Oldham, H., Roberts, L. J., MacLennan, K., and Schultz, F. W. **Dark adaptation of children in relation to dietary levels of vitamin A.** Jour. of Pediatrics, 1942, v. 20, June, p. 740.

After extensive study of the validity of the biophotometer test as an index of nutritional status with respect to vitamin A, Steininger and Roberts reported that, although there appeared to be some relationship between biophotometer readings and vitamin-A nutrition, the relation was "not close enough to warrant the use of the test as a means of diagnosing subclinical vitamin-A deficiency." Since then the adaptometer has been designed by Hecht and Shlaer, and the authors here report their experiments with that instrument.

The subjects used were children from three economic groups living on different diets, which varied in vitamin A. The authors found that the mean rod-thresholds of the three groups of children known to have had widely different vitamin-A intakes were almost identical. Approximately the same percentage of subjects in each group had subnormal dark adaptation. There was no correlation between adaptometer reading and daily vitamin-A intakes, although a number of children were apparently receiving less than 20 international units per kilogram per day in their diets. The above findings indicate either that the adaptometer does not measure the first signs of a vitamin-A deficiency or that such a deficiency is uncommon among children in this area. (16 references.)

Ralph W. Danielson.

Puntenney, Irving. **Retinal blood pressure.** Arch. of Ophth., 1942, v. 28, Oct., pp. 691-703.

The Kukan ophthalmodynamometer and binocular ophthalmoscope were used to determine the retinal arterial, venous, and capillary pressures in 25 normal individuals and in 40 patients with cardiovascular renal disease. The patients were divided into five groups according to the classification of Gifford and Macpherson. There was no particular pressure level at which retinal changes made their appearance, and no classification could be based on pressure readings. The Kukan instrument could not register some of the clinically encountered high pressures. Clinical improvement is not always followed by lowering of the pressure. The venous pressure was normal until decompensation occurred. The ophthalmodynamometer will remain a research instrument until more data on which to base interpretations are collected. The author discusses the physiology of the retinal circulation and the physics of the passage of fluids through tubular systems. (4 illustrations, references.)

John C. Long.

Sloan, L. L. **Light sense in pigmentary degeneration of the retina.** Arch. of Ophth., 1942, v. 28, Oct., pp. 613-631.

The first symptom of pigmentary degeneration of the retina is a disturbance of vision in dim light. It is hoped that by accurate tests of light thresholds one may be able to diagnose this condition earlier, and also to evaluate more accurately the results of treatment. The customary tests of scotopic vision, consisting of determination of dark adaptation of a single region of the retina, are inadequate in the study of pigmentary degeneration. Accuracy necessitates determination of the threshold throughout at least one meridian of the field from center to periphery. Fifteen patients showing either definite pigmentary degeneration or slight pigmentary defects were examined. The results indicate that the threshold gradient-curve of the dark-adapted eye shows greater defects in the midperipheral zone than in the far periphery and that the central field may not be affected until the defects in other regions are well advanced. (27 charts, references.) John C. Long.

11

OPTIC NERVE AND TOXIC AMBLYOPIAS

Greear, J. N., Jr. **Pits, or crater-like holes, in the optic disc.** Arch. of Ophth., 1942, v. 28, Sept., pp. 467-483.

Seventy cases of pits of the optic nerve have been reported in the literature. This condition is a congenital deformity in which there is a sharply delimited depression in the disc. In none of the cases reported did the pit extend beyond the disc margin. Usually the opening was oval, although some were circular, oblong, triangular, or slit-like. The crater was either shallow or as deep as 8 to 9 mm. Often a thin veil partially obscured the floor. The color of the pit has been described as black, gray, bluish, greenish, or combinations of these. A small paracentral scotoma was occasionally found. Several cases have been examined histologically and pigment epithelium has been found in all of these. The condition probably should be classified as an atypical coloboma, not resulting from disturbance in closure of the fetal fissure. All of the author's three cases of such pits showed central field changes, and one demonstrated a peripheral defect. (4 illustrations including one color plate; 1 table; bibliography.) John C. Long.

12

VISUAL TRACTS AND CENTERS

Yaskin, H. E., and Schlezinger, N. S. **Foster Kennedy syndrome associated with non-neoplastic intracranial conditions.** Arch. of Ophth., 1942, v. 28, Oct., pp. 704-710.

The syndrome of Foster Kennedy ordinarily indicates an expanding lesion of the basofrontal region. The localization should not rest upon this syndrome alone but must be confirmed by other neurologic manifestations. In case of doubt one should employ arteriography or cerebral air studies before subjecting a patient to craniotomy. The authors present two cases of Foster Kennedy syndrome not resulting from an expanding basofrontal lesion. The first case was of a 61-year-old man who had an enlargement of the blind spots, binasal inferior quadrant anopsia and a left central scotoma. Generalized arteriosclerosis was present. Craniotomy disclosed stretching of both optic nerves by enlarged, tortuous, and sclerotic anterior cerebral arteries. No neo-

plasm was found. Bilateral optic atrophy followed. The second case was of a 49-year-old woman with arterial hypertension, bilateral concentric field contraction, and a right central scotoma. There were no other neurologic signs. Encephalography showed no defect so no surgery was undertaken. It is assumed that the patient had either a chiasmal arachnoiditis or aneurysmal dilatation of sclerotic internal carotid arteries with compression of the optic nerves. Marked bilateral optic atrophy was later found. (3 visual field charts, references.) John C. Long.

13

EYEBALL AND ORBIT

Lurie, M. H. **Unilateral exophthalmos.** Trans. Pacific Coast Oto-Ophth. Soc., 1941, v. 26, pp. 106-108.

The author recognizes that unilateral exophthalmos secondary to acute infection of the frontal and ethmoid sinuses is very common. But he saw three cases in one week not caused by such infection. Among the noninfectious causes of unilateral exophthalmos enumerated in the literature are dermoid and sebaceous cysts, arteriovenous aneurysm, hyperthyroidism, xanthomatosis, tumor of the opic nerve, and pseudotumor of the orbit. The infectious exophthalmos is seen as a downward and outward protuberance of the eye. Noninfectious cases with lesions at the orbital apex produce direct exophthalmos. The diagnosis of other cases of noninfectious exophthalmos depends mostly on the X-ray findings, including exostoses of the orbit and osteomata of the frontal sinuses, rarely sclerosing fibroma, meningioma, Paget's disease, and commonly a primary mucocele of the frontal or ethmoid sinuses or mucocele secondary to incomplete frontal surgery. Other rather uncommon cases are mentioned as having occurred in the experience of the past twenty years at the Massachusetts Eye and Ear Infirmary. Naturally, complete X-ray study of the locality helps determine the indicated surgery, according to the pathology found. Lawrence G. Dunlap.

Mayfield, F. H. **Pulsating exophthalmos.** Amer. Jour. Ophth., 1942, v. 25, Dec., pp. 1496-1498. (2 illustrations.)

Poole, W. A. **Intermittent exophthalmos.** Trans. Amer. Acad. Ophth. and Otolaryng., 1942, Jan.-Feb., p. 112.

The author describes the different types of intermittent exophthalmos and reports a case due to varix of the blood vessels of the orbit. (Moving-picture illustrations, bibliography, discussion.) George H. Stine.

Soley, M. H. **Exophthalmos in patients with various types of goiter.** Arch. of Intern. Med., 1942, v. 70, Aug., pp. 206-220.

This article based on research rather than opinion should be read in its entirety by every physician interested in exophthalmos associated with thyroid disease. After mentioning the various diseases associated with exophthalmos and reviewing the literature on the theories of production of exophthalmos in thyroid disease, the author points out that some actual measurements are desirable, instead of depending on clinical appearance in which the examiner may be confused by "stare" and other misleading factors. The preface of his paper records measurements of the eyes of 65 normal persons, 106 persons with toxic diffuse goiter, 52 with toxic nodular goiter, 55 with nontoxic nodular goiter, and 2 patients measured before and after unilateral paralysis of the

cervical sympathetic ganglions. In these measurements the Hertel exophthalmometer was used: this instrument allows the observer to measure the distance between the deepest part of the lateral wall of the bony orbit and the point of greatest convexity of the cornea.

In normal persons the mean distance for each eye was 15.9 mm., and the range was 11.5 to 20 mm.: this agrees closely with the readings published by Ruedemann and by Wagener. The average reading in patients with toxic diffuse goiter was 17.7 mm.; a difference of 1.8 mm. from the normal of the group of 106 patients. Of these, 71 had clinical exophthalmos. The average was 18.55 mm.; thus in patients with clinical exophthalmos the eyes are more prominent by measurement than in patients without clinical exophthalmos. Out of the 78 patients followed five years or longer, 59 were treated by subtotal thyroidectomy, 16 by roentgen therapy and three by both. In 38 of the 78 patients the increase in the prominence of one or both eyes was 1.5 mm. or more at an average of 11 months after treatment; in 19 the increase was 0.5 to 1.0 mm.; in 9 no change occurred; in 6 a decrease of 0.5 to 1.0 mm. was noted; and in 6 the decrease was 1.5 or more. The patients with the greater increase in exophthalmos gained more weight. Only 3 of the 16 patients treated with roentgen rays alone had an increase of 1.5 mm. or more in one or both eyes, in contrast to 34 of 59 patients treated surgically. The author therefore agrees with Means that, in patients with exophthalmic goiter in whom exophthalmos is one of the prominent symptoms, radical subtotal thyroidectomy should probably be avoided. In the group with toxic nodular goiter the average reading was 16.55 mm. (0.65 above the normal). The readings for the nontoxic nodular group were 15.8 mm., essentially the same as for the normals. (3 tables, 24 references.)

Ralph W. Danielson.

Wallner, L. J. **Orbital cellulitis.** Annals of Otol., Rhin., and Laryng., 1942, v. 51, March, pp. 127-132.

The author states that 75 percent of all cases of orbital cellulitis are caused by acute sinusitis, usually of the frontal in adults and ethmoids in children. The marked edema of the lids and conjunctiva is caused by blockage of orbital veins in both orbital cellulitis and cavernous-sinus thrombosis. The recognized treatment is incision, but the author points out that if pus is not found beneath the periosteum it is not likely to be found in the orbit proper, and a search for it may be dangerous. Some men advise a radical external operation on the affected sinus, but the author favors conservative measures including chemotherapy, hot packs, therapeutic X ray, and local shrinking of the nose. (10 case reports.)

Ralph W. Danielson.

White, J. W. **Unilateral exophthalmos.** Trans. Pacific Coast Oto-Ophth. Soc., 1941, v. 26, pp. 203-206.

The author briefly summarizes two hundred consecutive cases of unilateral exophthalmos, giving positive, indicative, and suggestive X-ray findings and naming 16 different causes of exophthalmos. (2 case reports.)

Lawrence G. Dunlap.

14

EYELIDS AND LACRIMAL APPARATUS

Eden, K. C., and Trotter, W. R. **Lid retraction in toxic diffuse goiter.** The Lancet, 1942, Oct. 3, p. 385.

Lid retraction was found to be a more characteristic feature of toxic diffuse goiter than exophthalmos. Lid retraction appears to be governed by two factors, one of which is derived from the thyroid and the other possibly from the anterior pituitary gland. In most cases lid retraction was found to disappear when the thyrotoxicosis became inactive. Edna M. Reynolds.

Gifford, S. R., and Puntenney, I. **Modification of the Dickey operation for ptosis.** Arch. of Ophth., 1942, v. 28, Nov., pp. 814-820.

The Dickey operation for ptosis offers certain advantages over the Motais, the Trainor, and other procedures. It can be used only in patients with a normal superior rectus muscle. A strip of fascia lata is inserted beneath the superior rectus muscle and both ends of the strip are brought through a wound in the insertion of the levator. The ends of the fascial strip are then carefully stitched to the anterior surface of the tarsus, one medial and one lateral to the superior rectus. In this way the action of the superior rectus is transmitted to the upper lid at two points. The authors have modified the original technique by doing the entire operation through a cutaneous incision and inserting the fascia beneath the entire superior rectus rather than beneath the middle third. Five cases of ptosis corrected in this manner are reported. In selected cases the functional and cosmetic results are good. A wide and elliptical palpebral fissure is secured and the lid follows the eye well in vertical movements. (4 illustrations, references.) John C. Long.

Pathan, H. A. H. **Trans-grafting operation for trichiasis and entropion of the upper lid.** Indian Med. Gaz., 1942, v. 4, April, p. 204.

In the operation here described and illustrated, an elliptical skin graft is transferred down to the intermarginal space. Edna M. Reynolds.

Smith, Byron. **Use of Padgett dermatome in ophthalmic plastic surgery.** Arch. of Ophth., 1942, v. 28, Sept., pp. 484-489.

Reconstruction of the skin of the lids is best done by means of a full thickness graft from the upper lid after the manner of Le Fort-Wolfe. The skin of the upper lid is especially suitable because of its color, texture, and thinness. If skin from this area is not obtainable or if larger surfaces must be covered, as in orbital reconstruction, one must use split skin-grafts. One of the most serious difficulties encountered in skin grafting has been the cutting of a graft of suitable thickness and size. This difficulty is partially overcome by the use of a dermatome devised by Earl Padgett of the University of Kansas, and consisting of a drum and a movable knife. With it one can cut fairly uniform grafts which may be from 0.2 mm. in thickness to the full skin thickness and may be as large as 11 by 20 cm. The author describes some of the special precautions necessary in using this instrument. Rubber cement is very useful in handling thin skin grafts. It is used to cement the graft to "cilkloid," a cellulose-acetate membrane. The skin margins around the defect are then painted with rubber cement and the graft and the cilkloid membrane are applied to the wound. In this way the graft is securely held in place without the use of sutures. Rubber cement is also used to hold the skin grafts on forms for inlay grafting as in

orbital reconstruction. The author illustrates the methods with a case of carcinoma below the lower lid. A cicatricial ectopion was corrected with a Le Fort-Wolfe graft sutured into the lower lid, and the defect formed by excision of the carcinoma was closed with a split-skin graft secured by cilkloid and rubber cement. One illustration.) John C. Long.

Weiner, A. L., Gaynon, I. E., and Osherwitz, M. S. **Granuloma inguinale of the eyelid.** Amer. Jour. Ophth., 1943, v. 26, Jan., pp. 13-18. (5 illustrations, references.)

15

TUMORS

Appel, M., Saphir, O., Janota, M., and Strauss, A. A. **Complement-fixing antibodies (Brown-Pearce carcinoma) in the blood serum and in the aqueous fluid of the anterior chamber of the eye.** Cancer Research, 1942, v. 2, Aug., p. 576. (See Section 7, Uveal tract, sympathetic dis., and aqueous humor.)

Cheever, F. S., and Morgan, H. R. **Mechanism of tumor immunity as investigated by means of the intraocular inoculation of the Brown-Pearce carcinoma.** Cancer Research, 1942, v. 2, Oct., p. 675. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

Greene, H. S. N. **The participation of the anterior chamber of the eye in resistance phenomena related to tumor growth.** Cancer Research, 1942, v. 2, Oct., p. 669. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

Perera, C. A. **Lymphosarcoma of the lacrimal gland.** Arch. of Ophth., 1942, v. 28, Sept., pp. 522-529.

Approximately 5 percent of the primary tumors of the lacrimal gland arise from its lymphoid tissue. The classification of lymphoid tumors is difficult because often there is no sharp dividing line between the different types and because there may be a transition from one type to another. The author reports the case of a 58-year-old white woman who developed an irreplaceable exophthalmos with a small amount of hyperphoria. The orbit was explored through a conjunctival incision after a lateral canthotomy. An encapsulated tumor measuring 28 by 28 by 11 mm. was found in the lacrimal fossa, with an extension to the apex of the orbit. After removal of the tumor 4,500 roentgen units of X ray were given over the area. The patient was alive and well 4½ years after the operation, with no evidence of recurrence. Microscopic diagnosis of lymphosarcoma of the giant-follicle type was made. The author considers this a relatively benign lesion of the lacrimal gland, but potentionally capable of giving rise to generalized lymphosarcoma. (5 illustrations, bibliography.)

John C. Long.

16

INJURIES

Davidson, Morris. **The anterior segment contusion syndrome.** Ophth. Ibero-Amer., 1942, v. 4, no. 1, pp. 16-18 (in English) and pp. 19-21 (in Portuguese).

The results of ocular contusion give rise to many medicolegal controversies. To the group of symptoms associated with such injuries the author applies the term "anterior segment contusion syndrome." He reproduces the topographic chart which he has devised for use in the New York State Department of Labor, and by means of which he il-

lustrates 14 cases of injury all presenting special features. W. H. Crisp.

Haynes, L. K. **Wounds and deformities of the orbital region.** The Military Surgeon, 1942, v. 91, July, p. 83.

The author classifies the more common types of wounds and deformities of the orbital region which are likely to be encountered in war injuries. He also discusses the management of these conditions from the standpoint of early and immediate treatment and of the repair of late deformities.

T. E. Sanders.

Kuhn, H. S., and Wille, E. C., Jr. **Are welders subject to depletion of vital purple while at work?** Amer. Jour. Ophth., 1943, v. 26, Jan., pp. 63-68. (One table, 6 graphs.)

Minsky, Henry. **Surgical repair of recent lid lacerations.** Surg. Gynec. and Obst., 1942, v. 75, Oct., p. 449.

The general principles of the treatment of lid lacerations by various authors are summarized. The detailed steps in the technique of single and double intramarginal splinting sutures are described and sketched.

Edna M. Reynolds.

Town, A. E. **First aid for eye injuries.** Sight-Saving Review, 1942, v. 12, Sept., p. 163.

The most frequent injuries to which eyes are subjected are from foreign bodies. Corneal foreign bodies should be cared for by the surgeon. Penetrating wounds of the eyeball are always serious and call for immediate aid by an eye surgeon. Because of the rapid lid-reflex most thermal burns affect only the skin of the lids. In the third-degree burns of gasoline explosions in automobile or aeroplane accidents, the explosion is so rapid that there is no time for lid closure; hence the conjunctiva and cornea are involved and lid margins may be lost, producing severe deformities.

The gases of chemical warfare, if used in this war, will be disseminated by aeroplane spray and the civilian population will suffer if unguarded by gas masks. Lewisite may cause blindness. It penetrates deeply. Oils and ointments retain lewisite, and therefore should not be used. Immediate and repeated irrigations of two-percent solution of sodium bicarbonate are advised. Tear-gas symptoms are severe but the irritation is only temporary.

F. M. Crage.

Vila Ortiz, J. M. **The problem of simulation of industrial eye injuries.** Anales Argentinos de Oft., 1941, v. 2, Oct.-Nov.-Dec., p. 189. (See Section 18, Hygiene, sociology, education, and history.)

17

SYSTEMIC DISEASES AND PARASITES

Apple, C., and Bronstein, I. P. **Ocular findings in childhood endocrinopathies.** Amer. Jour. Ophth., 1943, v. 26, Jan., pp. 21-30. (8 illustrations, 9 tables, references.)

Francis, Edward. **Oculoglandular tularemia.** Archives of Ophth., 1942, v. 28, Oct., pp. 711-741. (See Section 5, Conjunctiva.)

Lemoine, A. N. **Allergies in ophthalmology.** Trans. Amer. Acad. Ophth. and Otolaryng., 1942, May-June, p. 231. (See Amer. Jour. Ophth., 1942, v. 25, Nov., p. 1402.)

Torres Estrada, Antonio. **Ophthalmoscopic observation of microfilarias in**

the vitreous of patients infected with onchocerciasis. Amer. Jour. Ophth., 1942, v. 25, Dec., pp. 1445-1448. (One table.)

Woltman, H. W. **Neuropsychiatric geriatrics.** Arch. of Ophth., 1942, v. 28, Nov., pp. 791-801; also Trans. Sec. on Ophth., Amer. Med. Assoc., 1942, 93rd mtg.

The pathological changes in the nervous system which accompany senility are described and the observation made that there is no clear correlation between the intensity of the clinical disability and the pathologic changes. Of a group of patients over sixty years of age referred for special neurologic study, 28 percent were found to have disturbances of the peripheral nerves. Sciatic neuritis, herpes, cranial-nerve palsies, and polyneuritis were observed. Cerebral arteriosclerosis accounted for much disability. The blood pressure was normal in 64 percent of the sclerotic group. Disturbances in gait were the most common complaints of the patients with cerebral arteriosclerosis. Giddiness and paresthesias were frequently noted.

Arteriosclerotic headache was studied in an unfruitful attempt to learn whether or not it had some special pathognomonic characteristic. Two thirds of the patients with headache had hypertension. Psychiatric disorders constitute the greatest social and economic problem in the aged. In the group studied, neuroses were the most commonly encountered psychic disorders. These were followed in frequency by the depressive and the delirious and confusional states and less frequently by psychoses more commonly ascribed to senility.

Vascular disturbances and Parkinsonism are discussed. Brain tumor is exceptionally difficult to diagnose in older people, because of confusion with other conditions and because choking of the discs is less frequent. There is great need for knowledge in the care of the aged. They must not be frustrated by enforced early retirement, dependency, and isolation. (4 figures, references.) John C. Long.

18

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Carris, L. H. **Twenty years in saving sight.** Sight-Saving Review, 1942, v. 12, Sept., p. 168.

The chief aim of the organized prevention-of-blindness movement has been to translate into social action the scientific discoveries in ophthalmology and other fields which offer possibilities of saving sight. Early ophthalmia neonatorum has been given the greatest attention. Statistics definitely show the value of the Credé technique of prevention. In 1906 and 1907, 28.2 percent of the new pupils enrolled in blind schools were blind from ophthalmia neonatorum. By 1922 this had been reduced to 14.2 percent; by 1942 to about 7 percent.

Reduction in blindness from trachoma was steady but slow until the sulfa drugs showed such good results. The discoverer of the sulfa drugs, Gerhard Domagk, is mentioned by the author.

The greatest advance in the field of venereal disease in the past twenty years has been to bring the subjects of syphilis and gonorrhea into open discussion as a problem of public health, rather than of morality.

Special classes for educating partially seeing children were started in 1913. By 1922, these schools numbered 144, and were located in 44 cities of 11 states. In 1942 there were 630 such

classes in 222 cities of 31 states, as well as in Hawaii and the District of Columbia.

While there has been a reduction of blindness from disease there is no evidence of a similar decrease in eye injuries. Industry as a whole has been slow to adopt safety measures.

F. M. Crage.

Crisp, W. H. **Edward Jackson, student and teacher.** Amer. Jour. Ophth., 1943, v. 26, Jan., pp. 1-12. (3 photographs, one drawing.)

Falcão, Pedro. **Optico and otico** ("optic" and "otic"). Arquivos Brasileiros de Oft., 1942, v. 5, Aug., pp. 186-190.

In the Portuguese language there has been a tendency to omit pronunciation of the letter "p" before the letter "t" in such words as "optics," and also to spell with a single consonant resulting combinations which at other times and in other languages have been represented by a doubling of the same letter. ("Optic" in Italian becomes "ottico.") Thus some Portuguese lexicographers and academicians have been insisting that the Portuguese word formerly written "optico" shall be written "otico." This manifestly creates confusion as between the adjective relating to the eye and the adjective relating to the ear, both assuming the same form but with different meanings. The author insists that the earlier spelling and corresponding pronunciation, namely "optico," of this Portuguese word must be retained. (Bibliography.)

W. H. Crisp.

Gifford, S. R. **Ophthalmology comes of age.** Quarterly Bull. Northwestern Univ. Med. School, 1942, v. 16, no. 3, p. 161.

The history of ophthalmology is briefly traced from the traveling eye-surgeons of the 18th century to the present time. The contributions of Brisseau, Daviel, Donders, Bowman, Graefe, Knapp, Fuchs, and Gonin are discussed and the importance of the various American institutes for research in ophthalmology is emphasized.

Edna M. Reynolds.

Harding, M. S. **The eyes and the military services.** Indiana State Med. Jour., 1942, v. 35, May, p. 246.

The visual requirements for various branches of the military services and the incidence of defects found in 19,923 registrants examined by selective service boards are listed. Myopia and myopic astigmatism account for 33 percent of the rejections.

Edna M. Reynolds.

Hartmann, Edward. **Eye surgery in war time.** Amer. Jour. Ophth., 1942, v. 25, Dec., pp. 1448-1457. (References.)

Hathaway, Winifred. **The ophthalmologist and the partially seeing child.** Sight-Saving Review, 1942, v. 12, Sept., p. 196.

The article deals with the mutual responsibility of the ophthalmologist and the school system for providing the partially seeing child with special educational opportunities. About one in five hundred of the school population requires special educational procedures and equipment because of eye difficulties.

In offering recommendations concerning educational placement of the partially seeing child, the ophthalmologist may consider the following groups: (1) children having a visual acuity between 20/70 and 20/200 in the better eye after refraction; (2) children

with progressive eye difficulties; (3) children having noncommunicable diseases of the eye or diseases of the body that seriously affect vision.

Only children of normal mentality are eligible for such classes. Since some parents feel that "special class" suggests mentally subnormal children, the ophthalmologist must be ready to reassure such parents that these classes are established in public school systems so that the affected children may enjoy the advantages of the regular curriculum. F. M. Crage.

Marshall, J., and Seiler, H. E. **A statistical analysis of 3,219 blind persons.** Brit. Jour. Ophth., 1942, v. 26, Aug., pp. 337-379, Sept., pp. 385-418, and Oct., pp. 433-466.

This paper analyzes 3,219 cases of blindness at the Regional Clinic for Certification of the Blind in Glasgow and Southwest Scotland during the period from 1929 to 1935. The methods of examination and the standards of blindness are described.

The visual acuity was under 3/60 Snellen in more than 90 percent of the cases. In more than half the cases, blindness occurred after the age of fifty years. The first year of life showed the highest rate for the onset of blindness and the latest years of life (seventy and beyond) showed the next highest rate.

The chief causes of blindness were cataract 16.77 percent, myopia 16.34 percent, venereal disease 13.95 percent, chronic septicemia 10.72 percent, glaucoma 8.69 percent, congenital anomalies 7.45 percent, and injury 6.42 percent.

In only one condition, namely diabetes, was there a significant excess of females affected. The incidence of males was significantly higher in glaucoma, congenital defects, acquired syphilis, injury, sympathetic ophthalmia, vascular disease, and disease of the central nervous system.

As regards occupation, miners and quarry workers showed a high incidence of blindness—39 per 10,000 of the population. It was of interest that myopia did not reveal a significant excess in any occupational order.

The results of this survey are compared with similar surveys in England and Wales. Particular attention is paid to questions of prevention and cure of blindness. (50 tables, references.)

Edna M. Reynolds.

Martins, Vieira, H. **Biography of J. Santa Cecilia.** Ophtalmos, v. 3, no. 1, p. 7-12.

Dr. Santa Cecilia, who played an important part in modern educational developments relating to Brazilian ophthalmology, was born in Brazil in 1886, began his career as a pharmacist, graduated in medicine in 1912, and settled in Belo Horizonte. He took up the specialty of ophthalmology in 1914, and in 1916 became Professor of Ophthalmology in the Faculty of Medicine in Belo Horizonte. He practiced for a while in São Paulo but returned to Belo Horizonte in 1918. He was for a time Associate Professor with the Penido Burnier Institute at Campinas. He occupied several important public offices. In 1935 he founded the Ophthalmological Society of Minas Gerais. He took an active part in the second, third, and fourth Brazilian Congresses of Ophthalmology in 1937, 1939, and 1941, and remained active in the affairs of the Congress and of the Minas Gerais society until the time of his death. He had the reputation of being a very skillful surgeon in spite of the fact that, like De Wecker, he had vision in only one eye. W. H. Crisp.

Smith, Virginia. **Administrative problems of eye clinics in caring for glaucoma patients.** Sight-Saving Review, 1942, v. 12, Sept., p. 182.

The special glaucoma clinic is the ideal way of treating glaucoma patients. Such a clinic as that in Brooklyn exists as a unit consisting of a director, medical assistants, a nurse, and a clerical assistant.

At the Boston clinic glaucoma patients and their families or friends attend bimonthly classes where lectures in simple understandable language are given. Every case of glaucoma and particularly those recently diagnosed should be referred to a social worker assigned to the eye clinic. This worker should make desirable contacts with the patient, instructing him as to the significance of the disease and obtaining valuable information for the attending ophthalmologist.

Follow-up outside of the clinic has been considered unethical by one clinic chief. A western medical society on the other hand has gone so far as to prepare a form letter to be used in private practice by its members for reminding glaucoma patients about their appointments. F. M. Crage.

Sverdlick, Jose. **Ophthalmology in the medicine of Hippocrates.** La Semana Med., 1942, v. 49, Aug. 20, pp. 440-448.

This rather lengthy paper consists in large part of direct translation into Spanish of passages from the Hippocratic writings, under the following headings: (1) Influence of environment upon origin, development, and evolution of eye diseases, including ophthalmic pathology in relation to meteorology; (2) Constitution, character, and eyes; (3) Ophthalmologic anatomy and physiology; (4) Ophthalmologic pathology and daily practice; (5) Prognosis in ophthalmic diseases, and ocular signs in general prognosis; (6) Medical and surgical therapeusis. W. H. Crisp.

Vila Ortiz, J. M. **The problem of simulation of industrial eye injuries.** Anales Argentinos de Oft., 1941, v. 2, Oct.-Nov.-Dec., p. 189.

The author divides the various types of malingering into groups and discusses different phases of each group. He gives the percentages of malingerers among industrial eye accidents, as reported by different writers. In the detection of simulated blindness the diploscope of Tarducci was found most useful. (3 figures.) Eugene M. Blake.

19

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Kornzweig, A. L. **Development of human eye at five and five-tenths-millimeter embryonic stage.** Arch. of Ophth., 1942, v. 28, Oct., p. 670.

This is a description of serial sections and of semidiagrammatic models of a 5.5-mm. human embryo, with special reference to the eye. There is the very beginning of invagination of the optic vesicle. The retina is composed of a nucleated and a marginal nonnucleated layer. The invasion of the retina by capillaries is observed. The cells of the lens plate show elongation as the earliest evidence of differentiation from the surface ectoderm. There is no evidence of extraocular muscles, sclera, choroid, lids, conjunctiva, cornea, iris, ciliary body, or lacrimal apparatus. In describing the developmental processes reference is made to possible congenital abnormalities. (7 figures, references.) John C. Long.

Terry, T. L. **Fibroblastic overgrowth of persistent tunica vasculosa lentis in infants born prematurely. 3. Studies in development and regression of hyaloid artery and tunica vasculosa lentis.** Amer. Jour. Ophth., 1942, v. 25, Dec., pp. 1409-1423. (15 illustrations, references.)

NEWS ITEMS

Edited by Dr. Ralph H. Miller
803 Carew Tower, Cincinnati

News items should reach the editor by the twelfth of the month

Deaths

Dr. Urban C. Billingsley, Hayward, California, died November 15, 1942, aged 67 years.

Dr. Luther G. Bunker, Waterville, Maine, died November 26, 1942, aged 74 years.

Dr. George B. Ribble, La Moure, North Dakota, died October 20, 1942, aged 64 years.

Dr. Edwin E. Jack, Brookline, Massachusetts, died November 16, 1942, aged 79 years.

Dr. George S. Laird, Westfield, New Jersey, died December 1, 1942, aged 65 years.

Dr. Andrew B. Nelles, Blacklick, Ohio, died November 23, 1942, aged 73 years.

Dr. Arne O. Arneson, McVille, North Dakota, died December 11, 1942, aged 63 years.

Dr. Howard T. Robinson, Cumberland, Maryland, died December 3, 1942, aged 62 years.

Dr. Henry Clay Knapp, Huntingburg, Indiana, died December 4, 1942, aged 76 years.

Dr. Linn M. Cudworth, Perry, Michigan, died December 9, 1942, aged 72 years.

Dr. Louis J. Sebert, Toronto, Ontario, Canada, died December 2, 1942, aged 56 years.

Dr. Archibald Bee, Florence, Colorado, died December 5, 1942, aged 77 years.

Dr. William D. Barry, Smethport, Pennsylvania, died December 5, 1942, aged 60 years.

Dr. Robert McKee Lapsley, Keokuk, Iowa, died January 5, 1943, aged 73 years.

Miscellaneous

At a recent symposium on aviation medicine, given before the Department of Ophthalmology of the Boston City Hospital for the purpose of training future medical officers for services with aviation units, the following lectures were presented: "The whole of the medical program in civil aviation" and "The effects of high altitude in aviation," by Dr. Ross A. McFarland; "The application of psychiatry to the military needs," by A. Warren Stearns, Comdr. (MC), U.S.N.R.; "The application of psychology to the selection and maintenance of aircraft pilots," by Edward J. Galway, Lt. (MC), U.S.N.R. Others in the series will include "Naval aviation," by John C. Adams, Capt. (MC), U.S.N.; "Demonstration of a naval flight physical examination," by Frank R. Philbrook, Lt. Comdr. (MC), U.S.N.R.; "Early treatment of traumatic injuries of the face and jaw," by Dr. Varaztad H. Kazanjian; and "Head and spinal injuries," by Dr. Donald Munro.

The American Board of Ophthalmology will hold two examinations in 1943, as follows: In New York City, June 4th and 5th; in Chicago, October 8th and 9th. Candidates will be required to appear for examination on two successive days. Please write at once for formal application blanks, to Dr. John Green, Secretary, 6830 Waterman Avenue, Saint Louis, Missouri.

Societies

The Reading Eye, Ear, Nose, and Throat Society held its seventeenth meeting on Wednesday, January 20, 1943. The guest speaker was Dr. Matthew S. Ersner, professor of otolaryngology at Temple University, Philadelphia, who lectured on "Deafness: Whose responsibility is it? Is it a lost cause? Mode of treatment."

The Reading Eye, Ear, Nose, and Throat Society has completed 13 weeks of broadcasting over station WEEU. The broadcasting covered the following subjects: 1. The eyes in air raids; 2. Colds and their results; 3. Hay fever and conditions like it; 4. What is sinusitis? 5. The tonsil question; 6. Deafness and hearing aids; 7. Hoarseness; 8. The management of cross eyes; 9. Eye irritations; 10. Eye hygiene; 11. Cataracts; 12. Glaucoma; 13. Running ears. A question-and-answer period will be held in the near future covering these subjects.

There will be no meeting of the Pacific Coast Society this year because of the war situation.

The Brooklyn Ophthalmological Society held its regular meeting on February 18, 1943, at

the Towers Hotel, Brooklyn, New York. Dr. Arthur W. Grace presented a paper, entitled "Treatment of ocular syphilis with malaria"; and Dr. Wendell L. Hughes gave a series of movie films showing the operative procedures used in (1) nevus pigmentosa of lids, (2) autogenous cartilage implant for depressed fracture of floor of orbit, and (3) lymphoma of conjunctiva, retinal detachment, tarsal transplant for trichiasis; and there was also a movie showing the use of the Padgett dermatome for taking split skin grafts.

At the meeting of the Washington, D.C., Ophthalmological Society on February 15, 1943, Dr. Grady Clay, guest speaker, lectured on "Ophthalmoloscopic findings in certain diseases." Dr. Edward Cummings presented a case report on "Coats's disease"; and Drs. Davis, Sheppard, and Romejko presented a case report on 'Leiomyoma of the iris." The following case presentations were made: "Hypertensive fundus," by Dr. Thomas R. Rees; "Atypical retinitis pigmentosa," by Dr. Benjamin Rones; and "Case of dislocated lenses," by Dr. Inez Wilber.

The Oxford Ophthalmological Congress for 1943 is to be held at Oxford on July 8th and 9th. The following Executive Officers have been appointed: Master, Mr. P. G. Doyne; Deputy Master, Dr. Bernard Samuels; University representative, Miss Ida Mann; Honorary Secretary, Dr. Frederick A. Anderson. The attendance at the July, 1942, meeting was 80.

Personals

Lt.-Col. Derrick T. Vail has sent in the following items:

"The annual Congress of the Ophthalmological Society of the United Kingdom will be held on April 30th and May 1st, at 1, Wimpole Street, London. There will be a discussion of thyrotoxicosis in its relation to ophthalmology; also a discussion on the scientific and clinical aspects of night vision, at which Prof. W. J. B. Riddell and Air Commodore P. C. Livingstone will be the opening speakers.

"The Oxford Ophthalmological Congress will be held at Oxford on July 6th to 8th. Members will as far as possible be accommodated at Holywell Manor. I expect to attend these meetings."

Dr. Joseph W. Charles, Saint Louis, recently presented a gift of a collection on ophthalmology to the library of the Saint Louis Medical Society.